



GASEOUS EMISSIONS COMPLIANCE STUDY

Performed For
United States Gypsum Company

Performed At The
USG Interiors, LLC
Cupola (P30) Facility
S12 Stack
Walworth, Wisconsin

Test Date
July 1, 2015

Report No.
TRC Environmental Corporation Report 235932B R1

Report Submittal Date
September 10, 2015

TRC Environmental Corporation
7521 Brush Hill Road
Burr Ridge, Illinois 60527
USA

T (312) 533-2042
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Report Certification

I certify that to the best of my knowledge:

- Testing data and all corresponding information have been checked for accuracy and completeness.
- Sampling and analysis have been conducted in accordance with the approved protocol and applicable reference methods (as applicable).
- All deviations, method modifications, or sampling and analytical anomalies are summarized in the appropriate report narrative(s).



Edward Peterson
Senior Technical Manager

September 10, 2015

Date

TRC was operating in conformance with the requirements of ASTM D7036-04 during this test program.

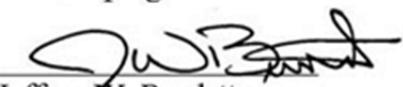

Jeffrey W. Burdette
TRC Air Measurements Technical Director



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GASEOUS EMISSIONS COMPLIANCE STUDY

1.0 INTRODUCTION

TRC Environmental Corporation (TRC) performed a sulfur dioxide (SO₂) test program at S12 Stack of the Cupola (P30) facility at USG Interiors, LLC in Walworth, Wisconsin on July 1, 2015. The tests were authorized by and performed for United States Gypsum Company.

The purpose of this test program was to determine SO₂ emission rates during normal operating conditions. The test program was conducted according to the TRC Test Protocol 235932B R1 Revision 1 dated May 27, 2015.

1.1 Project Contact Information

Participants			
Test Facility	USG Interiors, LLC 208 Adeline St. Walworth, Wisconsin 53184	Mr. Andrew Bauer 262-275-8158 (phone) 262-812-3523 (cell) abauer@usg.com	
Air Emissions Testing Body (AETB)	TRC Environmental Corporation 7521 Brush Hill Road Burr Ridge, Illinois 60527	Mr. Doug Ryan Group Manager 312-533-2042 (phone) 312-533-2070 (fax) dryan@trcsolutions.com	

The tests were conducted by Ben Cacao, Ryan Novosel, Skylar Rothgeb, Paul Powell, Rome Rothgeb, Greg Rock, Gavin Lewis and John Hamner of TRC. Documentation of the on-site ASTM D7036-04 Qualified Individual (QI) can be located in the appendix to this report.



2.0 SUMMARY OF RESULTS

The results of this test program are summarized in the table below. Detailed individual run results are presented in Section 6.0.

Parameter	S12 Stack
SO ₂ , ppm	921.0
SO ₂ , lb/hr (estimated)	154.8

The purpose of this emission testing program was to verify the estimated emission rate of sulfur dioxide from the cupola (Stack S12) and demonstrate that sulfur dioxide emissions from the cupola do not cause an exceedance of the state ambient air quality standards for sulfur oxides. The air quality impact analysis conducted by the WDNR on February 10, 2014, shows that an emission rate of 251.8 lb/hr meets the air quality standards for sulfur dioxide. (WDNR, February 20, 2014; ANALYSIS AND PRELIMINARY DETERMINATION FOR THE RENEWAL OF OPERATION PERMIT 265006830-P01 FOR USG INTERIORS, LLC LOCATED AT 208 ADELINNE ST, WALWORTH, WALWORTH COUNTY, WISCONSIN).

The table below summarizes the test methods used, as well as the number and duration of each at each test location:

Unit ID/ Sample Location	Parameter Measured	Test Method	No. of Runs	Run Duration
S12 Stack	SO ₂	USEPA 6C	3	60 min
	O ₂	USEPA 3A	3	60 min

3.0 DISCUSSION OF RESULTS

No problems were encountered with the testing equipment during the test program. Source operation appeared normal during the entire test program.

Fuel analysis of metallurgical coke were collected by TRC and analyzed by SGS North America Inc. in South Holland, Illinois. The calculated fuel factors for metallurgical coke were used to determine the emission rates on a pounds per million Btu (lb/MMBtu) basis. Emission rates in pounds per hour (lb/hr) were calculated by multiplying the emission rate in lb/MMBtu by the calculated heat input in millions of Btu per hour. Fuel analysis and operating data are appended to the report.



After issuing the original report (235932B) on August 17, 2015 it was discovered that an RTO exists between the Cupola exhaust and sample locations used for this test program. RTO natural gas usage was not included in the flow calculation. As a result, volumetric flow at the sample location (and SO₂ mass emissions) were underreported. An estimated SO₂ lb/hr value has since been calculated using the default natural gas fuel factor (8710) and the maximum burner rating of the RTO. The calculation and estimated mass emissions were provided to the Wisconsin DNR and have been determined to be an acceptable alternative (see attached communication).

4.0 SAMPLING AND ANALYSIS PROCEDURES

All testing, sampling, analytical, and calibration procedures used for this test program were performed in accordance with the methods presented in the following sections. Where applicable, the Quality Assurance Handbook for Air Pollution Measurement Systems, Volume III, Stationary Source Specific Methods, USEPA 600/R-94/038c, September 1994 was used to supplement procedures.

4.1 Determination of the Concentration of Gaseous Pollutants Using a Multi-Pollutant Sampling System

Concentrations of the pollutants in the following sub-sections were determined using one sampling system. The number of points at which sample was collected was determined in accordance with Method 7E specifications. An initial stratification check was performed prior to testing. The stack was found to be un-stratified, and subsequent tests were sampled from a single point.

A straight-extractive sampling system was used. A data logger continuously recorded pollutant concentrations and generated one-minute averages of those concentrations. All calibrations and system checks were conducted using USEPA Protocol 1 gases. Three-point linearity checks were performed prior to sampling. System bias and drift checks were performed using the low-level gas and either the mid- or high-level gas prior to and following each test run.

The Low Concentration Analyzers (those that routinely operate with a calibration span of less than 20 ppm) used by TRC are ambient-level analyzers. Per Section 3.12 of Method 7E, a Manufacturer's Stability Test is not required for ambient-level analyzers. Analyzer interference tests were conducted in accordance with the regulations in effect at the time that TRC placed an analyzer model in service.

4.1.1 O₂ Determination by USEPA Method 3A

This method is applicable for the determination of O₂ concentrations in controlled and uncontrolled emissions from stationary sources only when specified within the regulations. The O₂ analyzer was equipped with a paramagnetic-based detector.



4.1.2 SO₂ Determination by USEPA Method 6C

This method is applicable for the determination of SO₂ concentrations in controlled and uncontrolled emissions from stationary sources only when specified within the regulations. The SO₂ analyzer was equipped with an ultraviolet (UV) detector.

4.2 Determination of F-Factors by USEPA Method 19

This method is applicable for the determination of the pollutant emission rate using oxygen (O₂) or carbon dioxide (CO₂) concentrations and the appropriate F factor (the ratio of combustion gas volumes to heat inputs) and the pollutant concentration. The appropriate F-Factor was calculated from fuel analyses using the equations in Section 12.3.3.1 of Method 19.

5.0 QUALITY ASSURANCE PROCEDURES

TRC integrates our Quality Management System (QMS) into every aspect of our testing service. We follow the procedures specified in current published versions of the test Method(s) referenced in this report. Any modifications or deviations are specifically identified in the body of the report. We routinely participate in independent, third party audits of our activities, and maintain:

- Louisiana Environmental Lab Accreditation Program (LELAP) accreditation;
- Accreditation from the Stack Testing Accreditation Council (STAC) and the American Association for Laboratory Accreditation (A2LA) that our operations conform with the requirements of ASTM D 7036 as an Air Emission Testing Body (AETB).

These accreditations demonstrate that our systems for training, equipment maintenance and calibration, document control and project management will fully ensure that project objectives are achieved in a timely and efficient manner with a strict commitment to quality.

All calibrations are performed in accordance with the test Method(s) identified in this report. If a Method allows for more than one calibration approach, or if approved alternatives are available, the calibration documentation in the appendices specifies which approach was used. All measurement devices are calibrated or verified at set intervals against standards traceable to the National Institute of Standards and Technology (NIST). NIST traceability information is available upon request.

ASTM D7036-04 specifies that: "*AETBs shall have and shall apply procedures for estimating the uncertainty of measurement. Conformance with this section may be demonstrated by the use of approved test protocols for all tests. When such protocols are used, reference shall be made to published literature, when available, where estimates of uncertainty for test methods may be found.*" TRC conforms with this section by using approved test protocols for all tests.



6.0 TEST RESULTS SUMMARY



Gaseous Test Results Summary (SO₂ lb/hr calculated using Metallurgical Coke only)

Project Number:	235932	Start Date:	7/1/15
Customer:	USG Interiors	End Date:	7/1/15
Unit Identification:	Cupola Facility	Facility:	Walworth, WI
Sample Location:	S12 Stack	Recorded by:	John Hamner
RM Probe Type:	Extractive (Dry)		

Reference Method Results, As Measured Moisture Basis					
Run #	Date	Start Time	End Time	SO ₂ ppmvd	O ₂ % v/v dry
1	7/1/15	8:45	9:44	857.4	14.1
2	7/1/15	10:04	11:03	943.0	13.5
3	7/1/15	11:22	12:21	962.6	13.8
Average				921.0	13.8

Emission Rate Calculation Summary						
Run #	SO ₂ lb/MMBtu	Fd Factor	Metallurgical Coke Process Rate (lb/hr)	Averaged Heating Value (Btu/lb)	Heat Input MMBtu/hr	SO ₂ lb/hr
1	4.6	10,384	1,984.13	13,052	25.90	118.25
2	4.6	10,492				119.62
3	4.9	10,497				127.98
Average	4.7	10,458				121.95

Note: The Metallurgical coke (lb/hr) and the HHV (Btu/lb) values are dry basis.

Estimated Gaseous Test Results Summary
(SO₂ lb/hr estimated using Metallurgical Coke and Natural Gas Usage)

SO ₂ Concentration (3-run average):	921.0 ppmvd (measured)
F _d for coke:	10,458 dscf/MMBtu (measured from fuel samples)
F _d for natural gas:	8,710 dscf/MMBtu (Method 19 default value)
Coke use (3-run average):	25.9 MMBtu/hr (measured fuel use rate and measured heat value of 3 samples)
Natural Gas use:	8.4 MMBtu/hr (burner rating of thermal oxidizer)
Oxygen content of exhaust gas (3-run average):	13.8% (measured)
Conversion of SO ₂ ppm to lb/scf	1.660 × 10 ⁻⁷ (Table 19-1; USEPA Method 19)

Total Flow Rate (@ theoretical combustion conditions; 0% oxygen):

$$\text{Coke: } 25.9 \frac{\text{MMBtu}}{\text{hr}} \times 10,458 \frac{\text{dscf}}{\text{MMBtu}} = 270,962.2 \text{ dscfh}$$

$$\text{Natural Gas: } 8.4 \frac{\text{MMBtu}}{\text{hr}} \times 8,710 \frac{\text{dscf}}{\text{MMBtu}} = 73,164.0 \text{ dscfh}$$

$$\text{Total Flow: } 270,962.2 + 73,164.0 = 344,026.2 \text{ dscfh}$$

Adjusting to 13.8% oxygen:

$$Q = 344,062.2 \text{ dscfh} \times \frac{20.9}{20.9 - 13.8} = 1,012,697 \text{ dscfh}$$

Calculation of Emission Rate (3-run average):

$$\text{ER(SO}_2\text{)} = 1,012,697 \text{ dscfh} \times 921.0 \text{ ppmvd} \times 1.660 \text{ E}^{(-7)} = 154.8 \text{ lb} \frac{\text{SO}_2}{\text{hour}}$$

APPENDIX



AETB and QI Information Summary

Facility Name:	USG Interiors, LLC
Location:	S12 Stack
Test Date:	July 1, 2015

Test Parameters:	Methods 3A & 6C	Methods 3A & 6C
QI Last Name:	Lewis	Cacao
QI First Name:	Gavin	Ben
QI Middle Initial:	---	---
AETB Name:	TRC Environmental Corporation	TRC Environmental Corporation
AETB Phone No:	219-613-0163	630-280-9068
AETB Email:	glewis@trcsolutions.com	bcacao@trcsolutions.com
Group 3 Exam Date:	01-03-2013	9-20-2010
Provider Name:	Source Evaluation Society	Source Evaluation Society
Provider Email:	qstiprogram@gmail.com	qstiprogram@gmail.com

Test Parameters:	Methods 3A & 6C	Methods 3A & 6C
QI Last Name:	Rock	Hamner
QI First Name:	Gregory	John
QI Middle Initial:	---	---
AETB Name:	TRC Environmental Corporation	TRC Environmental Corporation
AETB Phone No:	262-960-3379	630-842-8402
AETB Email:	grpck@trcsolutions.com	jhamner@trcsolutions.com
Group 3 Exam Date:	9-3-2013	10-8-10
Provider Name:	Source Evaluation Society	Source Evaluation Society
Provider Email:	qstiprogram@gmail.com	qstiprogram@gmail.com

This is to Certify that:

Benigno Cacao

Is a Qualified Individual as defined in Section 8.3 of ASTM D7036-04 for the following test methods:

EPA Methods 3A, 6C, 7E, 10, 10B, 19, 20, 25A.

CEM Performance Specifications PS2, PS3, PS4, PS4A, PS5, PS6, PS7, PS8, and PS15

The individual has met the minimum experience requirements defined in Section 8.3.4.2 of ASTM D7036-04 and has successfully passed an internal comprehensive examination for the test methods designated above.

This certification is effective until:

09-20-2015



Date of Issue: 02-13-2013

Certificate Number: 00497

Edward J MacKinnon
Air Measurements Practice Quality Director



This is to Certify that:

Gregory Rock

Is a Qualified Individual as defined in Section 8.3 of ASTM D7036-04 for the following test methods:

EPA Methods 3A, 6C, 7E, 10, 10B, 19, 20, 25A.

CEM Performance Specifications PS2, PS3, PS4, PS4A, PS5, PS6, PS7, PS8, and PS15

The individual has met the minimum experience requirements defined in Section 8.3.4.2 of ASTM D7036-04 and has successfully passed a comprehensive examination for the test methods designated above.

This certification is effective until: 09-03-2018



Date of Issue: 09-11-2013

Certificate Number: 00616



Edward J MacKinnon
Air Measurements Practice Quality Director

This is to Certify that:

Gavin Lewis

Is a Qualified Individual as defined in Section 8.3 of ASTM D7036-04 for the following test methods:

EPA Methods 3A, 6C, 7E, 10, 10B, 19, 20, 25A.

CEM Performance Specifications PS2, PS3, PS4, PS4A, PS5, PS6, PS7, PS8, and PS15

The individual has met the minimum experience requirements defined in Section 8.3.4.2 of ASTM D7036-04 and has successfully passed an internal comprehensive examination for the test methods designated above.

This certification is effective until:

01-03-2018

Date of Issue: 02-13-2013

Certificate Number: 00458



Edward J MacKinnon
Air Measurements Practice Quality Director

This is to Certify that:

John P. Hammer

Is a Qualified Individual as defined in Section 8.3 of ASTM D7036-04 for the following test methods:

EPA Methods 3A, 6C, 7E, 10, 10B, 19, 20, 25A.

CEM Performance Specifications PS2, PS3, PS4, PS4A, PS5, PS6, PS7, PS8, and PS15

The individual has met the minimum experience requirements defined in Section 8.3.4.2 of ASTM D7036-04 and has successfully passed an internal comprehensive examination for the test methods designated above.

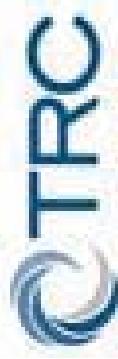
This certification is effective until:

10-08-2015



Date of Issue: 02-13-2013

Certificate Number: 00501



Edward J MacKinnon
Air Measurements Practice Quality Director

Shah, Varsha

From: Bergh, Ryan J - DNR <Ryan.Bergh@wisconsin.gov>
Sent: Monday, August 31, 2015 4:29 PM
To: Bauer, Andrew; Seeber, Andrew R - DNR
Cc: Volpentesta, George - DNR; Seitz, David; Spreitzer, Michael
Subject: RE: USG Walworth Stack Test

Hi Andrew:

Thank you for the e-mail in regards to the issue of not recording the thermal oxidizer natural gas consumption during the sulfur dioxide emission testing of the cupola. Your approach of using the thermal oxidizer burner rating and the Method 19 natural gas Fd Factor default value is an acceptable alternative to the department.

Let me know if you have any questions.

Regards,
Ryan

We are committed to service excellence.

Visit our survey at <http://dnr.wi.gov/customersurvey> to evaluate how I did.

Ryan Bergh, P.E.
Air Management Engineer – Air Management/AWaRe
Wisconsin Department of Natural Resources
Waukesha Service Center
141 NW Barstow St., Room 180
Waukesha, WI 53188
Phone: (262) 574-2155
Fax: (262) 574-2128
ryan.bergh@wisconsin.gov



From: Bauer, Andrew [mailto:ABauer@usg.com]
Sent: Friday, August 28, 2015 2:44 PM
To: Bergh, Ryan J - DNR; Seeber, Andrew R - DNR
Cc: Volpentesta, George - DNR; Seitz, David; Spreitzer, Michael
Subject: USG Walworth Stack Test

Ryan:

TRC has alerted us to an issue with the emission testing for sulfur dioxide emissions from the cupola that affects the measured emission rate. TRC relied upon the fuel factor (F_d) to determine the total flow, analyzing the metallurgical coke for composition and USG monitored the coke input during the test period. However, natural gas consumption in the thermal oxidizer was overlooked.

TRC has calculated the expected emission rate based upon the capacity of the burners in the oxidizer, as explained in the attached letter to USG. By this method, the maximum emission rate during the test period is calculated to be 154.8 pounds of sulfur dioxide per hour, rather than 121.95 pounds per hour as reported previously.

As stated in our permit:

"The purpose of this compliance emission testing is to verify the estimated emission rates of sulfur dioxide from Stack S12 and demonstrate that sulfur dioxide emissions from Stack S12 do not cause exceedance of the NAAQS for sulfur dioxide."

The emission rate used in the modeling analysis was 251.8 pounds per hour.

We are asking for your concurrence that this analysis is sufficient to satisfy the permit requirement to perform an emission test to demonstrate that the emission rate does not cause an exceedance of the air quality standard, because even under the worst-case, the emission rate is less than 62 percent of the rate used in the modeling analysis.

We are also asking that you consider this request as quickly as possible, so that if we need to re-test, we can schedule that within the allotted time frame or seek a timely extension.

TRC also informed us that their report incorrectly refers to the primary fuel used in the cupola as petcoke. The cupola fuel is metallurgical coke.

Thank you for your consideration. We are available to discuss this at your earliest convenience.

Regards,

Andrew Bauer
Engineering Manager
USG Walworth / Delavan
O-262-275-8158
C-262-812-3523

USG Interiors
Cupola Facility
S12 Stack

Time Charge	Coke Charged lbs
8:34	490
8:48	491
9:03	491
9:18	494
9:29	495
9:42	492
9:56	492
10:11	489
10:25	489
10:39	495
10:52	489
11:06	492
11:20	495
11:34	495
11:48	493
12:02	486
12:15	495
12:29	
Total Time min.	235
Total lbs coke	8,363
lb/hr, coke	2,135.23
Moisture (%), Average	7.08
lb/hr, coke dry	1,984.13
Heating Value Btu/lb, Average	13,052
Heat Input MMBtu/hr	25.90

USG - WALWORTH PLANT
CUPOLA CHARGE REPORT

DATE: 7-1-15

CHARGE NO.	CHARGE MINS.	TIME OF CHARGE	COKE	SLAG	BRICK CHIPS	SILICA	Baghouse D.P.	EXTRA COKE	COMMENTS
1	14	705	494	4206	138		3.48		B Krueger 7-3 GW 3.42
2	15	720	491	4169	135				
3	15	735	496	4177	137				
4	15	750	491	4144	136		4.20		
5	14	804	488	4192	145				
6	15	819	491	4151	136				
7	15	834	490	4181	139				
8	14	848	491	4197	141				
9	15	903	491	4188	138				
10	15	918	494	4194	138		4.16		GW 3.34
11	11	929	495	4085	139				
12	13	942	492	4216	136				
13	14	956	492	4217	140				
14	15	1011	485	4193	147				
15	14	1025	489	4184	146				
16	14	1039	495	4191	150				GW 3.33
17	13	1052	489	4185	147				
18	14	1106	492	4158	139		4.60		
19	14	1120	495	4192	139				
20	14	1134	495	4207	145				
21	14	1148	493	4184	136				
22	14	1202	486	4196	136		5.00		
23	13	1215	495	4156	142				
24	14	1207	492	4183	144				
25									
26									
27									
28									
29									
30									
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49									
50									
51									

Date
Test 1
Time

7/1/2015

Read By: Andy Bauer

Time	Pollution Control DP (in. H2O)	Comments
8:45	4.2	Test 1 start 8:45
9:00	4	
9:15	4.1	
9:30	4.4	
9:45	4.6	Test 1 Complete 9:45

Test 2
Time

Time	Pollution Control DP (in. H2O)	Comments
10:00	4.1	Test 2 start 10:04
10:15	4.2	
10:30	4.6	
10:45	5	
11:00	4.6	Test 2 Complete 11:04

Test 3
Time

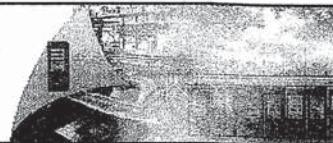
Time	Pollution Control DP (in. H2O)	Comments
11:15	4.8	Test 3 Start 11:22
11:30	5	
11:45	4.8	
12:00	4.6	
12:15	5	Test 3 Complete 12:22

Lime Feed(lb)	
8:43	6
9:43	6
10:46	6
11:30- 12:00 .1 lb /min	
12:01	3

WinCC™ Online Table Control Table - RT

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	Time	Temp
1	01/07/2015 08:30:03	1431
2	01/07/2015 08:31:03	1454
3	01/07/2015 08:32:03	1477
4	01/07/2015 08:33:03	1456
5	01/07/2015 08:34:03	1453
6	01/07/2015 08:35:03	1457
7	01/07/2015 08:36:03	1414
8	01/07/2015 08:37:03	1446
9	01/07/2015 08:38:03	1460
10	01/07/2015 08:39:03	1428
11	01/07/2015 08:40:03	1453
12	01/07/2015 08:41:03	1467
13	01/07/2015 08:42:03	1434
14	01/07/2015 08:43:03	1452
15	01/07/2015 08:44:03	1468
16	01/07/2015 08:45:03	1453
17	01/07/2015 08:46:03	1471
18	01/07/2015 08:47:03	1484
19	01/07/2015 08:48:03	1436
20	01/07/2015 08:49:03	1455
21	01/07/2015 08:50:03	1442
22	01/07/2015 08:51:03	1426
23	01/07/2015 08:52:03	1449
24	01/07/2015 08:53:03	1427
25	01/07/2015 08:54:03	1460
26	01/07/2015 08:55:03	1479
27	01/07/2015 08:56:03	1440
28	01/07/2015 08:57:03	1471
29	01/07/2015 08:58:03	1494
30	01/07/2015 08:59:03	1445
31	01/07/2015 09:00:03	1487
32	01/07/2015 09:01:03	1532
33	01/07/2015 09:02:03	1531
34	01/07/2015 09:03:03	1500
35	01/07/2015 09:04:03	1498
36	01/07/2015 09:05:03	1425
37	01/07/2015 09:06:03	1442
38	01/07/2015 09:07:03	1446
39	01/07/2015 09:08:03	1411
40	01/07/2015 09:09:03	1457
41	01/07/2015 09:10:03	1473
42	01/07/2015 09:11:03	1420
43	01/07/2015 09:12:03	1462
44	01/07/2015 09:13:03	1473
45	01/07/2015 09:14:03	1418
46	01/07/2015 09:15:03	1460
47	01/07/2015 09:17:03	1428
48	01/07/2015 09:18:03	1442
49	01/07/2015 09:20:03	1406

7/1/2015 12:26:06 PM

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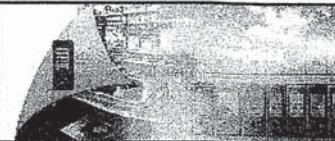
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WinCC™ Online Table Control Table - RT

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\WINCC1\WinCC_Project_Walworth_8-18-14\Walworth_8-18-14.mcp



	Time	Temp
50	01/07/2015 09:21:03	1413
51	01/07/2015 09:22:03	1457
52	01/07/2015 09:23:03	1421
53	01/07/2015 09:24:03	1454
54	01/07/2015 09:25:03	1501
55	01/07/2015 09:26:03	1466
56	01/07/2015 09:27:03	1474
57	01/07/2015 09:28:03	1471
58	01/07/2015 09:29:03	1425
59	01/07/2015 09:30:03	1469
60	01/07/2015 09:31:03	1484
61	01/07/2015 09:32:03	1429
62	01/07/2015 09:33:03	1453
63	01/07/2015 09:34:03	1446
64	01/07/2015 09:35:03	1436
65	01/07/2015 09:36:03	1418
66	01/07/2015 09:37:03	1451
67	01/07/2015 09:38:03	1490
68	01/07/2015 09:39:03	1453
69	01/07/2015 09:40:03	1455
70	01/07/2015 09:41:03	1458
71	01/07/2015 09:42:03	1438
72	01/07/2015 09:43:03	1447
73	01/07/2015 09:44:03	1434
74	01/07/2015 09:45:03	1442
75	01/07/2015 09:46:03	1459
76	01/07/2015 09:47:03	1430
77	01/07/2015 09:48:03	1448
78	01/07/2015 09:49:03	1462
79	01/07/2015 09:50:03	1434
80	01/07/2015 09:51:03	1464
81	01/07/2015 09:52:03	1472
82	01/07/2015 09:53:03	1432
83	01/07/2015 09:54:03	1458
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91	01/07/2015 10:03:03	1458
92	01/07/2015 10:04:03	1468
93	01/07/2015 10:05:03	1449
94	01/07/2015 10:06:03	1468
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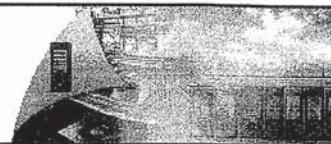
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105	01/07/2015 10:17:03	1453
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111	01/07/2015 10:23:03	1473
112	01/07/2015 10:24:03	1453
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114	01/07/2015 10:26:03	1456
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116	01/07/2015 10:28:03	1447
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127	01/07/2015 10:39:03	1443
128	01/07/2015 10:40:03	1464
129	01/07/2015 10:41:03	1438
130	01/07/2015 10:42:03	1454
131	01/07/2015 10:43:03	1461
132	01/07/2015 10:44:03	1442
133	01/07/2015 10:45:03	1456
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135	01/07/2015 10:47:03	1472
136	01/07/2015 10:48:03	1459
137	01/07/2015 10:49:03	1414
138	01/07/2015 10:50:03	1456
139	01/07/2015 10:51:03	1459
140	01/07/2015 10:52:03	1433
141	01/07/2015 10:53:03	1455
142	01/07/2015 10:54:03	1440
143	01/07/2015 10:55:03	1443
144	01/07/2015 10:56:03	1464
145	01/07/2015 10:57:03	1435
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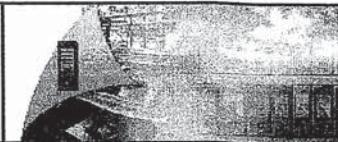
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153	01/07/2015 11:05:03	1462
154	01/07/2015 11:06:03	1425
155	01/07/2015 11:07:03	1444
156	01/07/2015 11:08:03	1450
157	01/07/2015 11:09:03	1427
158	01/07/2015 11:10:03	1452
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160	01/07/2015 11:12:03	1440
161	01/07/2015 11:13:03	1459
162	01/07/2015 11:14:03	1457
163	01/07/2015 11:15:03	1448
164	01/07/2015 11:16:03	1462
165	01/07/2015 11:17:03	1423
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169	01/07/2015 11:21:03	1457
170	01/07/2015 11:23:03	1435
171	01/07/2015 11:24:03	1458
172	01/07/2015 11:25:03	1432
173	01/07/2015 11:26:03	1456
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175	01/07/2015 11:28:03	1427
176	01/07/2015 11:29:03	1451
177	01/07/2015 11:30:03	1463
178	01/07/2015 11:31:03	1427
179	01/07/2015 11:32:03	1458
180	01/07/2015 11:33:03	1464
181	01/07/2015 11:34:03	1439
182	01/07/2015 11:35:03	1463
183	01/07/2015 11:36:03	1453
184	01/07/2015 11:37:03	1442
185	01/07/2015 11:38:03	1467
186	01/07/2015 11:39:03	1425
187	01/07/2015 11:40:03	1449
188	01/07/2015 11:41:03	1463
189	01/07/2015 11:42:03	1448
190	01/07/2015 11:44:03	1459
191	01/07/2015 11:45:03	1435
192	01/07/2015 11:46:03	1453
193	01/07/2015 11:47:03	1460
194	01/07/2015 11:48:03	1415
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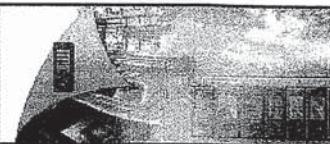
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200	01/07/2015 11:55:03	1466
201	01/07/2015 11:56:03	1440
202	01/07/2015 11:57:03	1464
203	01/07/2015 11:58:03	1442
204	01/07/2015 11:59:03	1447
205	01/07/2015 12:00:03	1461
206	01/07/2015 12:01:03	1451
207	01/07/2015 12:02:03	1447
208	01/07/2015 12:03:03	1463
209	01/07/2015 12:04:03	1420
210	01/07/2015 12:05:03	1449
211	01/07/2015 12:06:03	1475
212	01/07/2015 12:07:03	1441
213	01/07/2015 12:08:03	1457
214	01/07/2015 12:09:03	1465
215	01/07/2015 12:10:03	1441
216	01/07/2015 12:11:03	1467
217	01/07/2015 12:12:03	1432
218	01/07/2015 12:13:03	1455
219	01/07/2015 12:14:03	1466
220	01/07/2015 12:15:03	1425
221	01/07/2015 12:16:03	1442
222	01/07/2015 12:17:03	1457
223	01/07/2015 12:18:03	1417
224	01/07/2015 12:19:03	1448
225	01/07/2015 12:20:03	1482
226	01/07/2015 12:21:03	1447
227	01/07/2015 12:22:03	1456
228	01/07/2015 12:23:03	1439
229	01/07/2015 12:24:03	1448
230	01/07/2015 12:25:03	1463

7/1/2015 12:26:08 PM

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Part 60 Compliance Test Initial Stratification Check and Test Point Selection

Project Number: 235932 Date: 7/1/2015
Customer: USG Interiors Duct Shape: Round
Unit Identification: Cupola Facility Diameter: 4.6 feet
Sample Location: S12 Stack Port Length: 4 inches

Number of Points Used for Stratification Check: 3

Port/Point	NO _x (ppm)	SO ₂ (ppm)	CO (ppm)	CO ₂ (%vol)	O ₂ (%vol)
1-1		993.1			13.47
1-2		1002.68			13.84
1-3		1033.94			13.49
Mean:		1009.9			13.6

Parameter	Max Raw Difference	Max % Difference From Mean	Result	Number of Points
SO ₂	24.0	2.4	Un-Stratified	1
O ₂	0.2	1.8	Un-Stratified	1

Sampling line/strategy selected?: Single Point

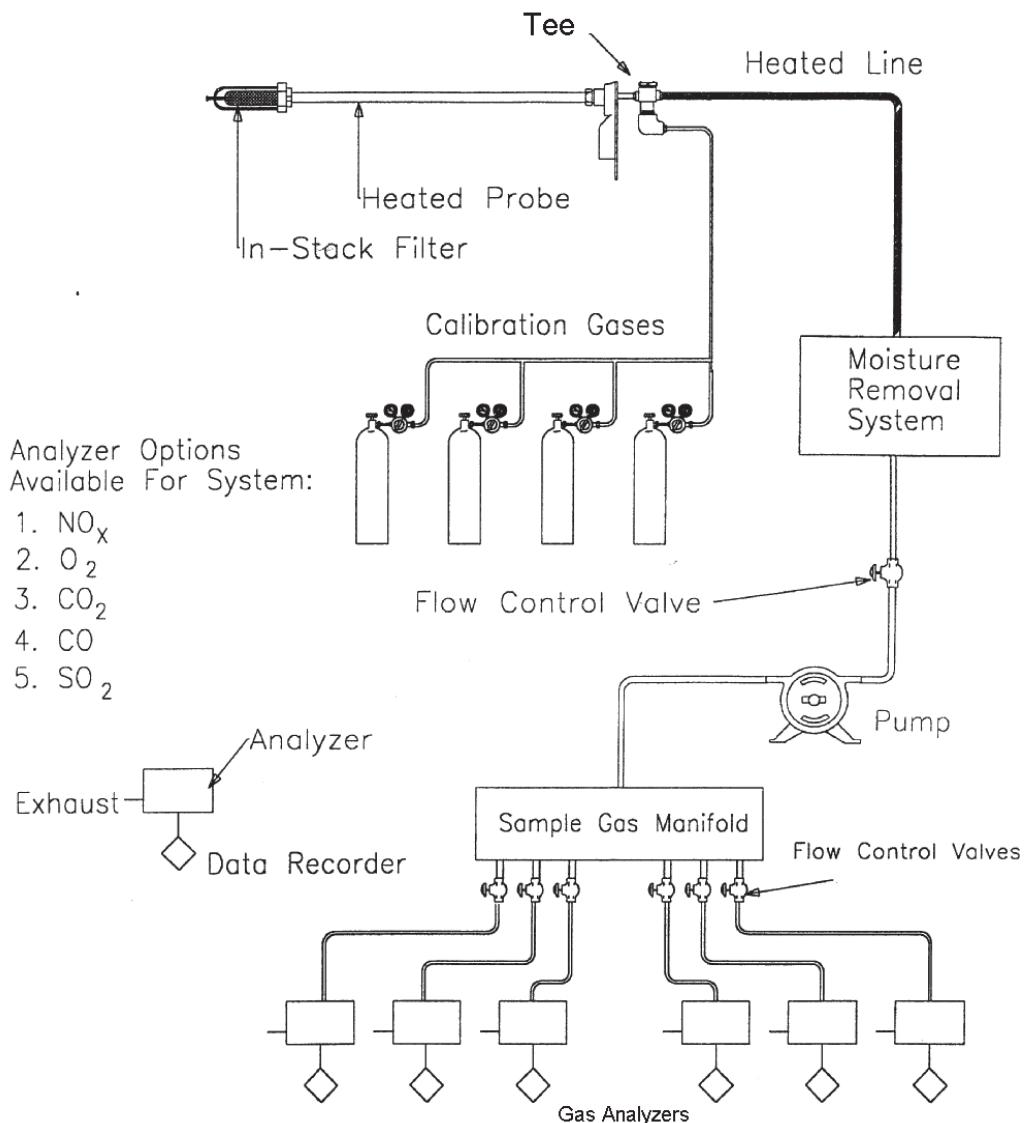
Stratification

USG Interiors
Cupola Facility
Walworth, WI
S12 Stack

Date & Time	SO2_2	O2_2	
7/1/2015 8:30	1015.18	13.35	
7/1/2015 8:31	981.43	13.41	
7/1/2015 8:32	1006.85	13.35	
7/1/2015 8:33	1025.19	13.42	
7/1/2015 8:34	993.10	13.47	Point 1
7/1/2015 8:35	959.35	13.45	
7/1/2015 8:36	943.09	13.66	
7/1/2015 8:37	941.01	13.76	
7/1/2015 8:38	998.93	13.74	
7/1/2015 8:39	1002.68	13.84	Point 2
7/1/2015 8:40	991.43	13.79	
7/1/2015 8:41	1038.10	13.69	
7/1/2015 8:42	1034.77	13.67	
7/1/2015 8:43	1034.73	13.46	
7/1/2015 8:44	1033.94	13.49	Point 3

Determination of Multiple Gaseous Pollutants Using an Extractive Sampling Train

USEPA Promulgated Methods 3A, 6C





Fuel Heating and F-Factor Value Calculations

Project No.: 235932
Customer: USG Interiors
Facility: Cupola Facility
Unit Identification: S12 Stack
Sample Description: Metallurgical Coke

Sample - 001 **Date:** July 1, 2015

% Hydrogen	0.28
% Carbon	87.30
% Sulfur	0.70
% Nitrogen	1.24
% Oxygen	0.83
HHV (Btu/lb)	12980

Fd= 10384 dscf/MMBtu
Fc= 2159 scf/MMBtu

Sample - 002 **Date:** July 1, 2015

% Hydrogen	0.16
% Carbon	88.91
% Sulfur	0.60
% Nitrogen	1.21
% Oxygen	0.39
HHV (Btu/lb)	13053

AVERAGE FUEL FACTORS

Fd=	10457 dscf/MMBtu
Fc=	2177 scf/MMBtu

Fd= 10492 dscf/MMBtu
Fc= 2186 scf/MMBtu

Sample - 003 **Date:** July 1, 2015

% Hydrogen	0.16
% Carbon	89.32
% Sulfur	0.62
% Nitrogen	1.13
% Oxygen	0.00
HHV (Btu/lb)	13123

Fd= 10497 dscf/MMBtu
Fc= 2185 scf/MMBtu



Analysis Report

July 28, 2015

TRC ENVIRONMENTAL CORPORATION
7521 BRUSH HILL ROAD
BURR RIDGE IL 60527

Page 1 of 1

ATTN: Gayle Swanson

Client Sample ID:	Sample # 1 7-1-15 09:00am	Sample ID By:	TRC ENVIRONMENTAL CORP
Date Sampled:	Jul 1, 2015	Sample Taken At:	Submitted
Date Received:	Jul 10, 2015	Sample Taken By:	Submitted
Product Description:	PETCOKE	P. O. #:	82944

SGS Minerals Sample ID: 491-1586744-001

	<u>Method</u>	<u>As Received</u>	<u>Dry</u>	<u>DAF</u>
Moisture, Total %	ASTM D4931	5.28		
Ash %	ASTM D4422 (Mod)	9.14	9.65	
Volatile Matter %	ASTM D3175	1.27	1.34	
Fixed Carbon (by diff) %	ASTM D3172 (by diff)	84.31	89.01	
Sulfur %	ASTM D4239 (Method A	0.66	0.70	
Gross Calorific Value Btu/lb	ASTM D5865	12295	12980	14366
Carbon %	ASTM D5373	82.70	87.30	
Hydrogen %	ASTM D5373	0.27	0.28	
Nitrogen %	ASTM D5373	1.18	1.24	
Oxygen (by diff) %	ASTM D5373 (by diff)	0.77	0.83	

<u>Tests</u>	<u>Result</u>	<u>Unit</u>	<u>Method</u>
UOM, Sample Weight	g	---	
Sample Weight	692.0	---	

Vanessa Chambliss
Branch Manager

SGS North America Inc. | Minerals Services Division
16130 Van Drunen Road South Holland IL 60473 t (708) 331-2900 f (708) 333-3060 www.sgs.com/minerals

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Analysis Report

July 28, 2015

TRC ENVIRONMENTAL CORPORATION
7521 BRUSH HILL ROAD
BURR RIDGE IL 60527

Page 1 of 1

ATTN: Gayle Swanson

Client Sample ID: Sample # 2 7-1-15 10:10am
Date Sampled: Jul 1, 2015
Date Received: Jul 10, 2015
Product Description: PETCOKE

Sample ID By:
Sample Taken At:
Sample Taken By:
P. O. #:

TRC ENVIRONMENTAL CORP
Submitted
Submitted
82944

SGS Minerals Sample ID: 491-1586744-002

	<u>Method</u>	<u>As Received</u>	<u>Dry</u>	<u>DAF</u>
Moisture, Total %	ASTM D4931	10.59		
Ash %	ASTM D4422 (Mod)	7.81	8.73	
Volatile Matter %	ASTM D3175	0.72	0.81	
Fixed Carbon (by diff) %	ASTM D3172 (by diff)	80.88	90.46	
Sulfur %	ASTM D4239 (Method A)	0.54	0.60	
Gross Calorific Value Btu/lb	ASTM D5865	11671	13053	14302
Carbon %	ASTM D5373	79.50	88.91	
Hydrogen %	ASTM D5373	0.15	0.16	
Nitrogen %	ASTM D5373	1.08	1.21	
Oxygen (by diff) %	ASTM D5373 (by diff)	0.33	0.39	

<u>Tests</u>	<u>Result</u>	<u>Unit</u>	<u>Method</u>
UOM, Sample Weight	g	---	
Sample Weight	593.1	---	

Vanessa Chambliss
Branch Manager

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Analysis Report

July 28, 2015

TRC ENVIRONMENTAL CORPORATION
7521 BRUSH HILL ROAD
BURR RIDGE IL 60527

Page 1 of 1

ATTN: Gayle Swanson

Client Sample ID:	Sample # 3 7-1-15 11:30am	Sample ID By:	TRC ENVIRONMENTAL CORP
Date Sampled:	Jul 1, 2015	Sample Taken At:	Submitted
Date Received:	Jul 10, 2015	Sample Taken By:	Submitted
Product Description:	PETCOKE	P. O. #:	82944

SGS Minerals Sample ID: 491-1586744-003

	<u>Method</u>	<u>As Received</u>	<u>Dry</u>	<u>DAF</u>
Moisture, Total %	ASTM D4931	5.36		
Ash %	ASTM D4422 (Mod)	8.30	8.77	
Volatile Matter %	ASTM D3175	0.67	0.71	
Fixed Carbon (by diff) %	ASTM D3172 (by diff)	85.67	90.52	
Sulfur %	ASTM D4239 (Method A	0.59	0.62	
Gross Calorific Value Btu/lb	ASTM D5865	12420	13123	14385
Carbon %	ASTM D5373	84.53	89.32	
Hydrogen %	ASTM D5373	0.15	0.16	
Nitrogen %	ASTM D5373	1.07	1.13	
Oxygen (by diff) %	ASTM D5373 (by diff)	<0.01	<0.01	

<u>Tests</u>	<u>Result</u>	<u>Unit</u>	<u>Method</u>
UOM, Sample Weight	g	---	
Sample Weight	517.2	---	

Vanessa Chambliss

Vanessa Chambliss
Branch Manager

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Chain of Custody Record

Example Calculations - F-Factor Derivation Calculations

Project Number: 235932
 Customer: USG Interiors
 Unit Identification: S12 Stack
 Sample Description: Metallurgical Coke

Test Date: July 1, 2015
 Facility: Cupola Facility
 Run #: Sample - 001

F_d Factor Derivation from Fuel Analysis

Refers to Sample ID: Sample - 001

$$F_d = \frac{[(3.64 \times \%H) + (1.53 \times \%C) + (0.57 \times \%S) + (0.14 \times \%N) - (0.46 \times \%O)]}{GCV} \times 10^6$$

Where:

F_d = gaseous volume of all components of combustion, less water, per unit heat (dscf/MMBtu)
 %H = percent by weight Hydrogen in fuel
 %C = percent by weight Carbon in fuel
 %S = percent by weight Sulfur in fuel
 %N = percent by weight Nitrogen in fuel
 %O = percent by weight Oxygen in fuel
 GCV = Gross Calorific Value of Fuel (Btu/lb)

From Fuel Analysis: (% by weight)

$\%H = \underline{0.28}$	$\%N = \underline{1.24}$	$GCV = \underline{12,980}$
$\%C = \underline{87.30}$	$\%O = \underline{0.83}$	
$\%S = \underline{0.70}$		

$$F_d = 10383.6 \frac{\text{DSCF exhaust}}{\text{MMBtu}}$$

F_c Factor Derivation from Fuel Analysis

Refers to Sample ID: Sample - 001

$$F_c = \frac{321 \times 10^3 \times (\%C)}{GCV}$$

Where:

F_c = volume of Carbon Dioxide per unit heat (dscf/MMBtu)

From Fuel Analysis: (% by weight)

$\%C = \underline{87.30}$	$GCV = \underline{12,980}$	
$F_c = 2159.0$	$\frac{\text{DSCF exhaust}}{\text{MMBtu}}$	

F_w Factor Derivation from Fuel Analysis

Refers to Sample ID: Sample - 001

$$F_w = \frac{[(5.57 \times \%H) + (1.53 \times \%C) + (0.57 \times \%S) + (0.14 \times \%N) - (0.46 \times \%O)]}{GCV} \times 10^6$$

Where:

F_w = volume of all components of combustion per unit heat (scf/MMBtu)

From Fuel Analysis: (% by weight)

$\%H = \underline{0.28}$	$\%N = \underline{1.24}$	$GCV = \underline{12,980}$
$\%C = \underline{87.30}$	$\%O = \underline{0.83}$	
$\%S = \underline{0.70}$		

$$F_w = 10425.2 \frac{\text{SCF exhaust}}{\text{MMBtu}}$$



Example Calculations - Effluent Gas Concentration Determination

Project Number:	235932	Test Date:	July 1, 2015
Customer:	USG Interiors	Facility:	Walworth, WI
Unit Identification:	Cupola Facility	Run #:	1
Sample Location:	S12 Stack		

$$C_{\text{gas}} = (C - C_0) \times \frac{C_{\text{ma}}}{C_m - C_0}$$

Where:

C_{gas} = Effluent gas concentration (ppm or %vol)

C = Average gas concentration indicated by analyzer (ppm or %vol)

C_0 = Average of pre- and post-test system bias checks using low range gas (ppm or % vol)

C_m = Average of pre- and post-test system bias checks using upscale gas (ppm or % vol)

C_{ma} = Actual concentration of upscale gas (ppm or % vol)

SO_2	$C = 855.6 \text{ ppm}$	$C_0 = 3.75 \text{ ppm}$
	$C_m = 912.175 \text{ ppm}$	$C_{\text{ma}} = 914.3 \text{ ppm}$

$\mathbf{C_{SO_2} = 857.359 \text{ ppm}}$

O_2	$C = 14.05 \text{ %vol}$	$C_0 = 0.09 \text{ %vol}$
	$C_m = 10.035 \text{ %vol}$	$C_{\text{ma}} = 10.07 \text{ %vol}$

$\mathbf{C_{O_2} = 14.135 \text{ %vol}}$

Note: Interim results are not rounded.



Example Calculations - Pollutant Emission Rate, Oxygen-Based Fuel Factor

Project Number:	235932	Test Date:	July 1, 2015
Customer:	USG Interiors	Facility:	Walworth, WI
Unit Identification:	Cupola Facility	Run #:	1

ER = Pollutant emission rate (lb/MMBtu)

C_{gas} = Pollutant concentration (ppm dry basis)

MW = Pollutant molecular weight (gr/gr-mole)

F_d = Oxygen-based fuel factor (dscf/MMBtu)

%O₂ = Concentration of oxygen in effluent gas (%vol dry basis)

1.660E-07 = Conversion constant for SO₂. From Table 19-1 of Method 19, 40CFR, Appendix A

For SO₂ $ER = C_{gas} \times 1.660E-07 \times F_d \times (20.9/(20.9-\%O_2))$

SO₂	$C_{gas} = 857.359 \text{ ppm}$	$\%O_2 = 14.135 \text{ %vol}$
	$F_d = 10384 \text{ dscf/MMBtu}$	

$$ER_{SO_2} = 4.5661 \text{ lb/MMBtu}$$

For CO $ER = C_{gas} \times 7.269E-08 \times F_d \times (20.9/(20.9-\%O_2))$

Note: Interim results are not rounded.



Example Calculations - Pollutant Emission Rate, Based on Heat Input

Project Number:	235932	Test Date:	July 1, 2015
Customer:	USG Interiors	Facility:	Walworth, WI
Unit Identification:	Cupola Facility	Run #:	1

For Heat Input $\frac{\text{HHV Btu/lb} \times \text{Process Rate lb/hr}}{1,000,000}$

For Heat Input $\frac{13052 \text{ Btu/lb} \times 1984.13 \text{ lb/hr}}{1,000,000}$

$$\text{Heat Input} = 25.90 \text{ MMBtu/hr}$$

$$ER = \text{lb/MMBtu} \times \text{Heat Input (MMBtu/Hr)}$$

Where:

ER = Pollutant emission rate (lb/hr)

lb/MMBtu = Pollutant emission factor in terms of pounds per million BTU of heat input

Heat Input (MMBtu/hr) = Heat input obtained from unit operating data or calculated from fuel heat content and usage rate

For SO₂ $ER = \text{SO}_2 \text{ lb/MMBtu} \times \text{Heat Input (MMBtu/hr)}$

lb/MMBtu = 4.5661

Heat Input = 25.90 MMBtu/hr

$$ER_{SO_2} = 118.2 \text{ lb/hr}$$

Note: Interim results are not rounded.



Instrumental Reference Method Field Data

Project Number:	235932	Start Date:	7/1/2015
Customer:	USG Interiors	End Date:	7/1/2015
Unit Identification:	Cupola Facility	Facility:	Walworth, WI
Sample Location:	S12 Stack	Recorded by:	John Hamner

Test Parameter			NO _x	SO ₂	CO	CO ₂	O ₂	Volumetric Flow Rate	Moisture Fraction	
Calibration Span, CS (Day 1)			-	2060	-	-	21.79			
Run No.	Date	First Minute	Last Minute	Run Average Raw Analyzer Responses					DSCFM	Bws
1	7/1/15	8:45	9:44	-	855.60	-	-	14.05	-	-
2	7/1/15	10:04	11:03	-	942.12	-	-	13.41	-	-
3	7/1/15	11:22	12:21	-	960.91	-	-	13.76	-	-

Test 1

USG Interiors
Cupola Facility
Walworth, WI
S12 Stack

Date & Time	SO2_2	O2_2
7/1/2015 8:45	1052.69	13.43
7/1/2015 8:46	979.76	13.41
7/1/2015 8:47	977.26	13.58
7/1/2015 8:48	881.42	13.86
7/1/2015 8:49	903.92	13.73
7/1/2015 8:50	886.01	13.81
7/1/2015 8:51	856.42	14.10
7/1/2015 8:52	783.50	14.21
7/1/2015 8:53	803.91	14.20
7/1/2015 8:54	799.33	14.16
7/1/2015 8:55	805.58	13.95
7/1/2015 8:56	840.46	13.85
7/1/2015 8:57	850.59	13.79
7/1/2015 8:58	924.76	13.72
7/1/2015 8:59	928.09	13.84
7/1/2015 9:00	890.59	13.89
7/1/2015 9:01	928.93	13.93
7/1/2015 9:02	905.59	14.03
7/1/2015 9:03	821.42	14.11
7/1/2015 9:04	797.25	14.16
7/1/2015 9:05	770.58	14.24
7/1/2015 9:06	734.74	14.33
7/1/2015 9:07	769.74	14.26
7/1/2015 9:08	783.08	14.25
7/1/2015 9:09	771.41	14.14
7/1/2015 9:10	833.08	14.06
7/1/2015 9:11	845.58	14.01
7/1/2015 9:12	819.75	13.99
7/1/2015 9:13	889.76	13.94
7/1/2015 9:14	901.42	14.08
7/1/2015 9:15	857.25	14.15
7/1/2015 9:16	891.42	14.13
7/1/2015 9:17	891.42	14.24
7/1/2015 9:18	850.59	14.28
7/1/2015 9:19	807.25	14.24
7/1/2015 9:20	803.08	14.35
7/1/2015 9:21	790.58	14.37
7/1/2015 9:22	815.58	14.28
7/1/2015 9:23	833.92	14.30
7/1/2015 9:24	805.58	14.26
7/1/2015 9:25	844.75	14.05

Test 1

USG Interiors
Cupola Facility
Walworth, WI
S12 Stack

Date & Time	SO2_2	O2_2
7/1/2015 9:26	847.25	14.02
7/1/2015 9:27	824.75	14.02
7/1/2015 9:28	873.92	13.91
7/1/2015 9:29	879.75	14.01
7/1/2015 9:30	858.09	14.13
7/1/2015 9:31	898.92	14.11
7/1/2015 9:32	893.09	14.20
7/1/2015 9:33	826.42	14.21
7/1/2015 9:34	808.08	14.23
7/1/2015 9:35	798.91	14.25
7/1/2015 9:36	784.75	14.24
7/1/2015 9:37	823.08	14.19
7/1/2015 9:38	864.75	14.23
7/1/2015 9:39	859.75	14.17
7/1/2015 9:40	872.25	13.93
7/1/2015 9:41	920.59	13.89
7/1/2015 9:42	916.42	13.97
7/1/2015 9:43	902.26	13.90
7/1/2015 9:44	954.76	13.69
Average	855.60	14.05

Test 2

USG Interiors
Cupola Facility
Walworth, WI
S12 Stack

Date & Time	SO2_2	O2_2
7/1/2015 10:04	970.60	13.19
7/1/2015 10:05	938.93	13.23
7/1/2015 10:06	973.10	13.04
7/1/2015 10:07	974.76	13.07
7/1/2015 10:08	919.76	13.17
7/1/2015 10:09	917.26	13.06
7/1/2015 10:10	898.09	13.13
7/1/2015 10:11	863.09	13.21
7/1/2015 10:12	850.59	13.20
7/1/2015 10:13	846.42	13.35
7/1/2015 10:14	830.58	13.52
7/1/2015 10:15	878.09	13.49
7/1/2015 10:16	877.25	13.55
7/1/2015 10:17	863.09	13.55
7/1/2015 10:18	926.43	13.46
7/1/2015 10:19	926.01	13.51
7/1/2015 10:20	921.01	13.37
7/1/2015 10:21	953.10	13.24
7/1/2015 10:22	908.80	13.21
7/1/2015 10:23	893.51	13.09
7/1/2015 10:24	887.26	13.12
7/1/2015 10:25	847.88	13.15
7/1/2015 10:26	858.50	13.09
7/1/2015 10:27	880.59	13.25
7/1/2015 10:28	868.92	13.41
7/1/2015 10:29	918.09	13.35
7/1/2015 10:30	967.26	13.48
7/1/2015 10:31	965.18	13.53
7/1/2015 10:32	1012.27	13.51
7/1/2015 10:33	954.35	13.59
7/1/2015 10:34	979.35	13.40
7/1/2015 10:35	983.93	13.29
7/1/2015 10:36	969.76	13.32
7/1/2015 10:37	986.85	13.18
7/1/2015 10:38	977.68	13.22
7/1/2015 10:39	943.51	13.33
7/1/2015 10:40	948.09	13.29
7/1/2015 10:41	970.60	13.40
7/1/2015 10:42	973.93	13.57
7/1/2015 10:43	1056.86	13.48
7/1/2015 10:44	1034.35	13.60

Test 2

USG Interiors
Cupola Facility
Walworth, WI
S12 Stack

Date & Time	SO2_2	O2_2
7/1/2015 10:45	994.77	13.63
7/1/2015 10:46	1021.44	13.59
7/1/2015 10:47	957.68	13.64
7/1/2015 10:48	954.76	13.49
7/1/2015 10:49	892.26	13.86
7/1/2015 10:50	820.58	14.13
7/1/2015 10:51	941.84	13.52
7/1/2015 10:52	960.60	13.55
7/1/2015 10:53	924.76	13.44
7/1/2015 10:54	946.43	13.43
7/1/2015 10:55	971.01	13.54
7/1/2015 10:56	986.43	13.57
7/1/2015 10:57	1042.27	13.53
7/1/2015 10:58	993.52	13.62
7/1/2015 10:59	1031.02	13.52
7/1/2015 11:00	1013.10	13.56
7/1/2015 11:01	968.10	13.60
7/1/2015 11:02	1000.18	13.47
7/1/2015 11:03	990.60	13.52
Average	942.12	13.41

Test 3

USG Interiors
Cupola Facility
Walworth, WI
S12 Stack

Date & Time	SO2_2	O2_2
7/1/2015 11:22	961.01	13.47
7/1/2015 11:23	954.76	13.63
7/1/2015 11:24	933.93	13.71
7/1/2015 11:25	993.10	13.74
7/1/2015 11:26	1003.52	13.88
7/1/2015 11:27	992.68	13.78
7/1/2015 11:28	1028.52	13.72
7/1/2015 11:29	940.59	13.75
7/1/2015 11:30	964.35	13.58
7/1/2015 11:31	971.01	13.53
7/1/2015 11:32	926.01	13.55
7/1/2015 11:33	1007.68	13.43
7/1/2015 11:34	1001.02	13.62
7/1/2015 11:35	963.93	13.70
7/1/2015 11:36	959.35	13.68
7/1/2015 11:37	946.43	13.84
7/1/2015 11:38	931.01	13.88
7/1/2015 11:39	974.35	13.95
7/1/2015 11:40	944.76	14.05
7/1/2015 11:41	921.84	13.94
7/1/2015 11:42	949.34	13.96
7/1/2015 11:43	976.85	13.99
7/1/2015 11:44	961.43	13.74
7/1/2015 11:45	1010.18	13.71
7/1/2015 11:46	979.76	13.78
7/1/2015 11:47	1012.68	13.68
7/1/2015 11:48	1027.69	13.69
7/1/2015 11:49	998.52	13.80
7/1/2015 11:50	987.27	13.75
7/1/2015 11:51	1008.52	13.84
7/1/2015 11:52	983.60	13.99
7/1/2015 11:53	985.60	13.97
7/1/2015 11:54	913.92	14.02
7/1/2015 11:55	888.21	13.76
7/1/2015 11:56	883.09	13.79
7/1/2015 11:57	845.17	13.77
7/1/2015 11:58	917.26	13.58
7/1/2015 11:59	930.59	13.63
7/1/2015 12:00	939.76	13.64
7/1/2015 12:01	983.10	13.68
7/1/2015 12:02	958.51	13.79

Test 3

USG Interiors
Cupola Facility
Walworth, WI
S12 Stack

Date & Time	SO2_2	O2_2
7/1/2015 12:03	943.93	13.79
7/1/2015 12:04	903.51	14.07
7/1/2015 12:05	928.93	13.98
7/1/2015 12:06	963.93	13.93
7/1/2015 12:07	990.60	13.98
7/1/2015 12:08	952.26	13.92
7/1/2015 12:09	983.97	13.82
7/1/2015 12:10	936.43	13.80
7/1/2015 12:11	944.76	13.60
7/1/2015 12:12	986.43	13.49
7/1/2015 12:13	963.10	13.57
7/1/2015 12:14	978.10	13.50
7/1/2015 12:15	993.10	13.58
7/1/2015 12:16	971.43	13.69
7/1/2015 12:17	958.93	13.68
7/1/2015 12:18	958.93	13.78
7/1/2015 12:19	913.92	13.90
7/1/2015 12:20	951.43	13.89
7/1/2015 12:21	969.76	13.97
Average	960.91	13.76



Instrumental Reference Method Field Data

Project Number:	235932	Date:	7/1/2015
Customer:	USG Interiors	Facility:	Walworth, WI
Unit Identification:	Cupola Facility	Recorded by:	John Hamner
Sample Location:	S12 Stack	Fc Factor:	-

RM Analyzer Information			
Reference Method Probe Type (Moisture Basis):			Extractive (Dry)
Pollutant	Manufacturer	Model #	Serial Number
SO ₂	Thermo	43C	509110869
O ₂	Servomex	1440	1420D/3420

Reference Method Initial Calibration Error Test							
Pollutant	Cal Gas Level	Cal Gas Cylinder Information			Analyzer Response	Absolute Difference	% Cal Error
		Concentration	Exp Date	ID #			
SO ₂	Low	0	10/23/22	EB0039073	0.00	0.00	0.00
	Mid	914.3	12/15/22	CC232513	913.92	0.38	0.02
	High	2060	03/31/22	SX48565	2057.04	2.96	0.14
O ₂	Low	0	10/23/22	EB0039073	0.01	0.01	0.05
	Mid	10.07	10/27/22	CC262176	10.06	0.01	0.05
	High	21.79	05/09/22	SX47594	21.93	0.14	0.64



Instrumental Reference Method Field Data

Project Number:	235932	Start Date:	7/1/2015
Customer:	USG Interiors	End Date:	7/1/2015
Unit Identification:	Cupola Facility	Facility:	Walworth, WI
Sample Location:	S12 Stack	Recorded by:	John Hamner

Actual Concentration of the Upscale Calibration Gas, C _{MA}					
	NO _x	SO ₂	CO	CO ₂	O ₂
C _{MA} (Day 1)	-	914.3	-	-	10.07

System Responses to Zero Calibration Gas										
Run No.	NO _x		SO ₂		CO		CO ₂		O ₂	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	-	-	5.00	2.50	-	-	-	-	0.09	0.09
2	-	-	2.50	0.00	-	-	-	-	0.09	0.10
3	-	-	0.00	0.50	-	-	-	-	0.10	0.11

System Responses to Upscale Calibration Gas										
Run No.	NO _x		SO ₂		CO		CO ₂		O ₂	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	-	-	913.76	910.59	-	-	-	-	10.04	10.03
2	-	-	910.59	916.42	-	-	-	-	10.03	10.07
3	-	-	916.42	908.92	-	-	-	-	10.07	10.06



Instrumental Reference Method Calibration Data

Project Number:	235932	Start Date:	7/1/2015
Customer:	USG Interiors	End Date:	7/1/2015
Unit Identification:	Cupola Facility	Facility:	Walworth, WI
Sample Location:	S12 Stack	Recorded by:	John Hamner

SO₂ System Bias/Calibration Error and Drift Summary

Run #	Calibration Gas Level	Span	Cdir	Initial Values		Final Values		Drift (% of span)
		Span Gas Concentration (ppm)	Direct Cal Response (ppm)	System Response (ppm)	System Bias (% of span)	System Response (ppm)	System Bias (% of span)	
1	Low Level Gas	2060	0	5.00	0.2	2.50	0.1	0.1
	Upscale Gas	2060	913.92	913.76	0.0	910.59	-0.2	0.2
2	Low Level Gas	2060	0	2.50	0.1	0.00	0.0	0.1
	Upscale Gas	2060	913.92	910.59	-0.2	916.42	0.1	0.3
3	Low Level Gas	2060	0	0.00	0.0	0.50	0.0	0.0
	Upscale Gas	2060	913.92	916.42	0.1	908.92	-0.2	0.4



Instrumental Reference Method Calibration Data

Project Number:	235932	Start Date:	7/1/2015
Customer:	USG Interiors	End Date:	7/1/2015
Unit Identification:	Cupola Facility	Facility:	Walworth, WI
Sample Location:	S12 Stack	Recorded by:	John Hamner

O₂ System Bias/Calibration Error and Drift Summary

Run #	Calibration Gas Level	Span	Cdir	Initial Values		Final Values		Drift (% of span)
		Span Gas Concentration (%vol)	Direct Cal Response (ppm)	System Response (%vol)	System Bias (% of span)	System Response (%vol)	System Bias (% of span)	
1	Low Level Gas	21.79	0.01	0.09	0.4	0.09	0.4	0.0
	Upscale Gas	21.79	10.06	10.04	-0.1	10.03	-0.1	0.0
2	Low Level Gas	21.79	0.01	0.09	0.4	0.10	0.4	0.0
	Upscale Gas	21.79	10.06	10.03	-0.1	10.07	0.0	0.2
3	Low Level Gas	21.79	0.01	0.10	0.4	0.11	0.5	0.0
	Upscale Gas	21.79	10.06	10.07	0.0	10.06	0.0	0.0

Linearity

USG Interiors
Cupola Facility
Walworth, WI
S12 Stack

Date & Time	SO2_2	O2_2
7/1/2015 7:24	0.00	0.00
7/1/2015 7:25	0.00	0.01
7/1/2015 7:26	558.72	0.03
7/1/2015 7:27	1953.28	-0.01
7/1/2015 7:28	2001.20	-0.01
7/1/2015 7:29	2057.04	-0.01
7/1/2015 7:30	2057.87	-0.02
7/1/2015 7:31	1652.25	6.94
7/1/2015 7:32	4.17	21.90
7/1/2015 7:33	0.00	21.93
7/1/2015 7:34	0.00	21.94
7/1/2015 7:35	8.75	21.93
7/1/2015 7:36	822.21	1.85
7/1/2015 7:37	915.17	0.05
7/1/2015 7:38	913.92	0.04
7/1/2015 7:39	915.17	0.02
7/1/2015 7:40	607.52	4.14
7/1/2015 7:41	0.42	10.04
7/1/2015 7:42	0.00	10.06
7/1/2015 7:43	0.00	10.06

Pre 1 - Response

USG Interiors
Cupola Facility
Walworth, WI
S12 Stack

Date & Time	SO2_2	O2_2
7/1/2015 8:01	297.74	6.32
7/1/2015 8:02	254.19	3.50
7/1/2015 8:03	132.51	1.14
7/1/2015 8:04	5.42	0.08
7/1/2015 8:05	5.00	0.09
7/1/2015 8:06	23.75	0.08
7/1/2015 8:07	874.29	0.09
7/1/2015 8:08	913.76	0.09
7/1/2015 8:09	911.01	0.09
7/1/2015 8:10	885.59	1.48
7/1/2015 8:11	45.55	9.99
7/1/2015 8:12	5.00	10.02
7/1/2015 8:13	2.92	10.04
7/1/2015 8:14	50.01	0.85
7/1/2015 8:15	0.00	0.09

Post 1

USG Interiors
Cupola Facility
Walworth, WI
S12 Stack

Date & Time	SO2_2	O2_2
7/1/2015 9:45	1004.77	13.69
7/1/2015 9:46	991.43	13.76
7/1/2015 9:47	888.09	14.10
7/1/2015 9:48	512.05	5.31
7/1/2015 9:49	11.71	0.12
7/1/2015 9:50	5.00	0.11
7/1/2015 9:51	2.50	0.09
7/1/2015 9:52	289.40	0.11
7/1/2015 9:53	887.26	0.11
7/1/2015 9:54	908.09	0.11
7/1/2015 9:55	908.92	0.11
7/1/2015 9:56	910.59	0.11
7/1/2015 9:57	641.23	4.88
7/1/2015 9:58	10.88	10.01
7/1/2015 9:59	5.00	10.03

Post 2

USG Interiors
Cupola Facility
Walworth, WI
S12 Stack

Date & Time	SO2_2	O2_2
7/1/2015 11:04	947.68	13.55
7/1/2015 11:05	949.76	12.61
7/1/2015 11:06	109.43	9.92
7/1/2015 11:07	7.17	10.06
7/1/2015 11:08	5.13	10.07
7/1/2015 11:09	13.50	5.59
7/1/2015 11:10	1.25	0.11
7/1/2015 11:11	0.04	0.11
7/1/2015 11:12	0.00	0.10
7/1/2015 11:13	0.04	0.09
7/1/2015 11:14	378.70	0.11
7/1/2015 11:15	896.42	0.11
7/1/2015 11:16	910.17	0.10
7/1/2015 11:17	916.42	3.08

Post 3

USG Interiors
Cupola Facility
Walworth, WI
S12 Stack

Date & Time	SO2_2	O2_2
7/1/2015 12:22	952.26	13.90
7/1/2015 12:23	553.06	11.23
7/1/2015 12:24	13.00	10.06
7/1/2015 12:25	5.50	10.06
7/1/2015 12:26	3.83	10.06
7/1/2015 12:27	2.13	3.97
7/1/2015 12:28	0.50	0.12
7/1/2015 12:29	0.50	0.11
7/1/2015 12:30	69.63	0.13
7/1/2015 12:31	855.59	0.13
7/1/2015 12:32	907.26	0.11
7/1/2015 12:33	908.92	0.11
7/1/2015 12:34	910.59	2.71



Response Time Verification

Project Number:	235932	Test Date:	7/1/2015
Customer:	USG Interiors	Facility:	Walworth, WI
Unit Identification:	Cupola Facility	Recorded By:	John Hamner
Sample Location:	S12 Stack		

Upscale Response Check							
Pollutant	Cal Gas Level	Cal Gas Conc.	Start Time	Stable Response	Upscale Target Response	Time at Target	Response Time
SO ₂	Mid	914.3	8:05:00	913.76	868.1	8:07:00	0:02:00
O ₂	Mid	10.1	8:09:00	10.04	9.5	8:11:00	0:02:00

Target Response is 95% of the Pre 1 System Response from the Upscale Bias Test

Start time is the time at which gas is introduced upstream of the probe.

Time at target is the time at which the required target response is achieved.

Response time is the difference between the two.

Downscale Response Check						
Pollutant	Cal Gas Level	Cal Gas Conc.	Start Time	Downscale Target Response	Time at Target	Response Time
SO ₂	Mid	914.3	8:09:00	45.7	8:11:00	0:02:00
O ₂	Mid	10.1	8:13:00	0.5	8:15:00	0:02:00

Target Response is 0.5 ppm or 5.0 percent of the upscale gas concentration (whichever is less restrictive)

System Response Times	
Pollutant	Response Time
SO ₂	0:02:00
O ₂	0:02:00

System response is the longer of the responses to zero and upscale gas.

ANALYZER INTERFERENCE RESPONSE TEST

USEPA Reference Method: 6C Analyzer Type: SO₂

Analyzer Manufacturer: TECO Model Number: 43C

Date of Test: 2/23/2007

Test No.	Time	SO ₂ ppm (wet)		Percent Difference
		Method 6C	Method 6	
1	1713-1743	92.73	92.02	0.77
2	1752-1822	214.16	209.55	2.20
3	1919-1949	734.74	735.69	-0.13
Total Percent Difference				2.84

Total percent difference allowable is $\leq 7\%$.

Detailed interference response test data is maintained on file and is available upon request.

ANALYZER INTERFERENCE RESPONSE TEST

USEPA Reference Method: 3A Analyzer Type: O₂

Analyzer Manufacturer: Servomex Model Number: 1440

Analyzer Span: 0-25%

Test Performed by: D. Grabowski Date: 1/23/1998

Interference Gas	Interference Gas Concentration	Affect of Interference Gas on Analyzer	
		Analyzer Response, ppm	Percent of Span
NO _x	498.0 ppm	0.02	0.08
SO ₂	208.9 ppm	0.02	0.08
CO	450.7 ppm	0.00	0.00
CO ₂	10.06%	0.00	0.00
O ₂	22.5%	--	--
Total Response (sum)		0.04	0.16

Total affect on analyzer reading must be < 2% of analyzer span.

Detailed interference response test data is maintained on file and is available upon request.

CERTIFICATE OF BATCH ANALYSIS

Grade of Product: CEM-CAL ZERO

Part Number: NI CZ15A
Cylinder Analyzed: XC032574B
Laboratory: MWE - Elk Grove (SAP) - IL
Analysis Date: Oct 23, 2014
Lot Number: 136-400448242-1

Reference Number: 136-400448242-1
Cylinder Volume: 142.0 CF
Cylinder Pressure: 2000 PSIG
Valve Outlet: 580

Expiration Date: Oct 23, 2022

ANALYTICAL RESULTS

Component	Requested Purity	Certified Concentration
NITROGEN	99.9995 %	99.9995 %
CARBON DIOXIDE	< 1.0 PPM	<LDL 0.12 PPM
NOx	< 0.1 PPM	< 0.1 PPM
SO2	< 0.1 PPM	< 0.1 PPM
THC	< 0.1 PPM	0.06 PPM
CARBON MONOXIDE	< 0.5 PPM	<LDL 0.12 PPM

Permanent Notes: Airgas certifies that the contents of this cylinder meet the requirements of 40 CFR 72.2

Cylinders in Batch:

CC111698, CC147767, CC158800, CC177257, CC193410, CC248043, CC35226, CC3997, CC425708, CC430433, CC447265, EB0031381, EB0039073, EB0039373, EB0048357, SG9136019BAL, SG9149350BAL, SG9163812, XC032574B

Impurities verified against analytical standards traceable to NIST by weight and/or analysis.



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CERTIFICATE OF ANALYSIS

Grade of Product: EPA Protocol

Part Number: E05NI90E15A0009
 Cylinder Number: CC232513
 Laboratory: ASG - Chicago - IL
 PGVP Number: B12014
 Gas Code: CO,CO2,NO,NOX,SO2,BALN

Reference Number: 54-124463573-2A
 Cylinder Volume: 149.4 CF
 Cylinder Pressure: 2015 PSIG
 Valve Outlet: 660
 Certification Date: Dec 15, 2014

Expiration Date: Dec 15, 2022

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 600/R-12/531, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a volume/volume basis unless otherwise noted.

Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

ANALYTICAL RESULTS

Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
NOX	900.0 PPM	911.7 PPM	G1	+/- 0.7% NIST Traceable	12/08/2014, 12/15/2014
CARBON MONOXIDE	900.0 PPM	888.9 PPM	G1	+/- 0.9% NIST Traceable	12/09/2014
NITRIC OXIDE	900.0 PPM	911.7 PPM	G1	+/- 0.7% NIST Traceable	12/08/2014, 12/15/2014
SULFUR DIOXIDE	900.0 PPM	914.3 PPM	G1	+/- 0.6% NIST Traceable	12/08/2014, 12/15/2014
CARBON DIOXIDE	9.000 %	9.029 %	G1	+/- 0.6% NIST Traceable	12/08/2014
NITROGEN	Balance				

CALIBRATION STANDARDS

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	11060327	CC2139	988.8 PPM CARBON MONOXIDE/NITROGEN	+/- 0.4%	Dec 13, 2016
PRM	12312	680179	10.01 PPM NITROGEN DIOXIDE/NITROGEN	+/- 2.0%	Oct 15, 2014
NTRM	11060457	CC344091	979.8 PPM NITRIC OXIDE/NITROGEN	+/- 0.5%	Jan 10, 2017
GMIS	124206889102	CC320508	4.979 PPM NITROGEN DIOXIDE/NITROGEN	+/- 2.0%	May 04, 2015
NTRM	12062613	CC366209	996.8 PPM SULFUR DIOXIDE/NITROGEN	+/- 0.5%	Jun 22, 2018
NTRM	97050819	SG9166477BAL	7.029 % CARBON DIOXIDE/NITROGEN	+/- 0.5%	May 01, 2016

The SRM, PRM or RGM noted above is only in reference to the GMIS used in the assay and not part of the analysis.

ANALYTICAL EQUIPMENT

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
Nexus 470 AEP0000428	FTIR	Nov 11, 2014
CO-1 HORIBA VIA-510 TKPPF7FG	NDIR	Nov 24, 2014
Nexus 470 AEP0000428	FTIR	Dec 11, 2014
Nexus 470 AEP0000428	FTIR	Dec 11, 2014
Nexus 470 AEP0000428	FTIR	Dec 11, 2014

Triad Data Available Upon Request



Signature on file

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MATHESON TRI-GAS

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Certificate of Analysis - EPA Protocol Mixtures

1650 Enterprise Parkway
Twinsburg, Ohio 44087
216-648-4000

Customer: GE ENERGY
Cylinder Number: SX-48565
Cylinder pressure: 1500 psig
Last Analysis date: 3/31/2014
Expiration Date: 3/31/22

Protocol: Reference # Lot #
G1 644709 109-96-12317

**DO NOT USE THIS CYLINDER WHEN THE
PRESSURE FALLS BELOW 100 PSIG**

REPLICATE RESPONSES

Component: Sulfur Dioxide
Certified Conc: 2060 ppm ± 11 ppm

Date: 3/21/2014 Date: 3/31/2014
2061 ppm 2057 ppm
2060 ppm 2058 ppm
2060 ppm 2058 ppm

BALANCE GAS: Nitrogen

REFERENCE STANDARDS

Component: Sulfur Dioxide
SRM #: SRM-1663a
Sample #: 92-F-05
Cylinder #: CAL-015089
Concentration: 1480.2 ppm

CERTIFICATION INSTRUMENTS

Component: Sulfur Dioxide
Make/Model: SO2 VIA-510 HIGH
Serial Number: BBP770XS
Measurement Principle: NDIR
Last Calibration: 3/31/2014

Notes: RECERTIFICATION
T194080

The certification was performed according to EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards May 2012, using procedure G1 and/or G2. U.S EPA Vendor ID Number: D42013,
PGVP Participation Date: 01/01/13, PGVP Renewal Date: 01/01/14

Analyst

Date 3/31/2014

CERTIFICATE OF ANALYSIS Grade of Product: EPA Protocol

Airgas Specialty Gases
12722 South Wentworth Avenue
Chicago, IL 60628
(773) 785-3000 Fax: (773) 785-1928
www.airgas.com

Part Number: E03NI81E15A37P2 Reference Number: 54-124460773-1
Cylinder Number: CC262176 Cylinder Volume: 150.3 CF
Laboratory: ASG - Chicago - IL Cylinder Pressure: 2015 PSIG
PGVP Number: B12014 Valve Outlet: 590
Gas Code: CO2,O2,BALN Certification Date: Oct 27, 2014

Expiration Date: Oct 27, 2022

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 600/R-12/531, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a volume/volume basis unless otherwise noted.

Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

ANALYTICAL RESULTS					
Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
CARBON DIOXIDE	9.000 %	8.863 %	G1	+/- 1.0% NIST Traceable	10/27/2014
OXYGEN	10.00 %	10.07 %	G1	+/- 0.9% NIST Traceable	10/27/2014
NITROGEN	Balance				

CALIBRATION STANDARDS					
Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	97050816	SG9167530BAL	7.029 % CARBON DIOXIDE/NITROGEN	+/- 0.5%	May 01, 2016
NTRM	06120102	CC195595	9.898 % OXYGEN/NITROGEN	+/- 0.7%	Jul 26, 2018

ANALYTICAL EQUIPMENT					
Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration			
CO2-1 HORIBA VIA-510 V1E3H7P5	NDIR	Oct 02, 2014			
O2-1 HORIBA MPA-510 3VUYL9NR	Paramagnetic	Oct 22, 2014			

Triad Data Available Upon Request



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**MATHESON**

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1700 Scepter Rd
Waverly, TN 37185
931-296-3357

Certificate of Analysis - EPA Protocol Mixtures

Customer: TRC STOCK

Cylinder Number: SX47594
Cylinder Pressure: 1900psig
Last Analysis Date: 5/8/2014
Expiration Date: 5/9/2022

Protocol: G1-Carbon Monoxide
Reference #: T195659-01
Lot#: 9304609638

G-2 Oxygen

DO NOT USE THIS CYLINDER WHEN THE PRESSURE FALLS BELOW 100 PSIG

Component: Carbon Dioxide
Certified Conc: 17.80% +/- 0.02% ABS
Component: Oxygen
Certified Conc: 21.79% +/- 0.10% ABS

REPLICATE RESPONSES
Date: 5/8/2014
17.80
17.80
17.80
Date: 5/8/2014
21.80
21.78
21.79

BALANCE GAS: Nitrogen

REFERENCE STANDARDS:

Component: Carbon Dioxide
Reference Standard: PRM
Cylinder #: D249793
Concentration: 19.814%
Exp. Date: 10/3/2017
NIST Sample # VSL PRIMARY

Component: Oxygen
Reference Standard: SRM
Cylinder #: FF22295
Concentration: 20.863%
Exp. Date: 8/23/2021
NIST Sample # 71-E-27

CERTIFICATION INSTRUMENTS

Component: Carbon Dioxide	Component: Oxygen
Make/Model: Horiba VIA-510	Make/Model: Horiba MPA-510
Serial Number: 41679080021	Serial Number: U1LSAGS6
Measurement Principle: NDIR	Measurement Principle: Paramagnetic
Last Calibration: 4/21/2014	Last Calibration: 4/28/2014

Notes:

The certification was performed according to EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards May 2012, using procedure G1 and/or G2. U.S EPA Vendor ID Number: D62014, PGVP Participation Date: 01/01/14, PGVP Renewal Date: 01/01/15

Analyst:

Julie Higgins

Date: 5/9/2014



EMISSIONS TEST PROTOCOL

Prepared For
United States Gypsum Company

At The
USG Interiors, LLC
Cupola Facility – S12 Stack
Walworth, Wisconsin

TRC ENVIRONMENTAL CORPORATION Protocol 235932B
Revision 1

May 27, 2015

Submitted By

D.G.T. G.M.

Daniel Grabowski
Project Director
312-533-2024, Phone
dgrabowski@trcsolutions.com, Email



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8.0 QUALITY ASSURANCE PROCEDURES.....	3

GENERAL INFORMATION APPENDED:

Sample Point Location Information
Test Train Diagrams
Data Sheets
Calculation and Nomenclature Sheet
Emission Rate Calculations
Calibration Data

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TRC Protocol Compliance template revised 2/4/13



1.0 INTRODUCTION

TRC Environmental Corporation (TRC) will perform a sulfur dioxide (SO₂) emissions test program to determine SO₂ emissions on the S12 stack of Cupola facility of USG Interiors, LLC in Walworth, Wisconsin. This program are completed in accordance with the methods and at the source sampling locations listed below. All required analyses, including the analysis of any quality assurance samples supplied by the agency in question, are completed.

1.1 Project Contact Information

Location	Address	Contact
Test Facility	USG Interiors, LLC 208 Adeline St. Walworth, Wisconsin 53184 Facility No. 265006830	Mr. Andrew Bauer Engineering Manager (262) 275 - 8158 (phone) (262) 812 - 3523 (cell) abauer@usg.com
Test Company Representative	TRC Environmental Corporation 7521 Brush Hill Road Burr Ridge, Illinois 60527	Daniel Grabowski Project Director (312) 533-2042 (phone) (312) 533-2070 (fax) dgrabowski@trcsolutions.com

2.0 TEST REQUIREMENTS

The following table presents a list of the pollutants to be tested at each emission source, the applicable emission limits and the applicable rules or regulations for each emission limit:

Emission Point	Pollutant Tested	Emission Limit	Method/Regulation Citation
Cupola Stack S12	SO ₂	The purpose of this compliance emission testing is to verify the estimated emission rates of sulfur dioxide from Stack S12 and demonstrate that sulfur dioxide emissions from Stack S12 do not cause an exceedance of the NAAQS for sulfur dioxide.	USEPA Method 6C, 40CFR60, Appendix A.

The air quality impact analysis conducted on February 10, 2014 shows that this maximum theoretical emission rate (251.8 lb/hr) meets the air quality standards for sulfur dioxide, (WDNR Preliminary Determination dated February 20, 2014). Therefore, the purpose of the emission test on the cupola is to revise the estimated emission rate if necessary, and demonstrate that the resulting emission rate will not cause an exceedance of the NAAQS. Such a demonstration may require dispersion modeling as was conducted during the operation permit review process. If the emission rate is determined to be 251.8 pounds per hour or less, no revision of the emission rate and no revised dispersion modeling will be necessary, and a demonstration that the emissions do not cause an exceedance of the NAAQS for sulfur dioxide will be accomplished.



3.0 SPECIFIC TEST PROCEDURES

Detailed test procedures are described in Section 7 of this protocol. Three complete test runs will be performed for each constituent in accordance with the following USEPA methods.

1. O₂ content of the stack gas will be determined by USEPA Method 3A, 40CFR60 during each test run.
2. Sulfur dioxide (SO₂) emissions will be determined in accordance with USEPA Method 6C, 40CFR60. Each test will consist of one hour of continuous testing.

4.0 TEST PROGRAM SCHEULE

Refer to plant submittals for specific dates.

Day	Task	Crew	On-Site Hours
1	Travel to plant, set up at the Cupola stacks.	2	2
3	Perform gaseous testing at the Cupola stack and return to office.	2	8

All test days are considered consecutive 8-hour weekdays, generally scheduled between the hours of 8:00 a.m. and 4:30 p.m., unless otherwise stated.

5.0 PROJECT PERSONNEL

- 1 - Lead Field Engineer
- 1 - Technology Specialists

6.0 PLANT REQUIREMENTS

TRC must be supplied with the following items in order to complete this test program:

1. Safe access to test positions.
2. Electrical power 110 V, 30 A, 60 cycle service at the test locations.
3. Four-inch (or larger) test ports cleaned and loose prior to arrival of test crew.
4. Any scaffolding or aerial man-lifts required reaching the test locations. Scaffolding shall be erected by a qualified person and must meet minimum OSHA standards as listed in 29 CFR 1926.451.
5. Sufficient lighting at the test site.
6. Elevators safety checked and certified in good operation.
7. Hoist equipment, if required.
8. Plant or pollution control equipment operating data, in the format required by the applicable regulatory agency, for inclusion in the report.
9. Washroom facilities for use by members of the test crew.
10. A shelter at the test location, if weather conditions warrant.
11. Plant assistance in hoisting equipment to and from test site.
12. Stable operations and the required load or production rate during the test period.
13. Communication between the test location and the control room.



14. Parking location to place TRC mobile trailer within 200 feet of sampling locations with access to multiple 110 V, 20 A, 60 cycle or 480 V, 50 A, 60 cycle circuits.

7.0 TEST PROCEDURES

All testing, sampling, analytical, and calibration procedures used for this test program are performed in accordance with the methods presented in the following sections. Where applicable, the Quality Assurance Handbook for Air Pollution Measurement Systems, Volume III, Stationary Source Specific Methods, USEPA 600/R-94/038c, September 1994 is used to supplement procedures.

7.1 Determination of the Concentration of Gaseous Pollutants Using a Multi-Pollutant Sampling System

Concentrations of the pollutants in the following sub-sections were determined using one sampling system. The number of points at which sample was collected was determined in accordance with 40CFR60 specifications.

A straight-extractive sampling system was used. A data logger continuously recorded pollutant concentrations and generated one-minute averages of those concentrations. All calibrations and system checks were conducted using USEPA Protocol 1 gases. Three-point linearity checks were performed prior to sampling, and in the event of a failing system bias or drift test (and subsequent corrective action). System bias and drift checks were performed using the low-level gas and either the mid- or high-level gas prior to and following each test run.

The Low Concentration Analyzers (those that routinely operate with a calibration span of less than 20 ppm) used by TRC are ambient-level analyzers. Per Section 3.12 of Method 7E, a Manufacturer's Stability Test is not required for ambient-level analyzers. Analyzer interference tests were conducted in accordance with the regulations in effect at the time that TRC placed an analyzer model in service.

7.1.1 O₂ Determination by USEPA Method 3A

This method is applicable for the determination of O₂ concentrations in controlled and uncontrolled emissions from stationary sources only when specified within the regulations. The O₂ analyzer is equipped with a paramagnetic-based detector.

7.1.2 SO₂ Determination by USEPA Method 6C

This method is applicable for the determination of SO₂ concentrations in controlled and uncontrolled emissions from stationary sources only when specified within the regulations. The SO₂ analyzer is equipped with an ultraviolet (UV) detector.

8.0 QUALITY ASSURANCE PROCEDURES

TRC integrates our Quality Management System (QMS) into every aspect of our testing service. We follow the procedures specified in current published versions of the test Method(s) referenced in this report. Any modifications or deviations are specifically identified in the body of the report. We routinely participate in independent, third party audits of our activities, and maintain:

- Louisiana Environmental Lab Accreditation Program (LELAP) accreditation;



- Accreditation from the Stack Testing Accreditation Council (STAC) and the American Association for Laboratory Accreditation (A2LA) that our operations conform with the requirements of ASTM D 7036 as an Air Emission Testing Body (AETB).

These accreditations demonstrate that our systems for training, equipment maintenance and calibration, document control and project management will fully ensure that project objectives are achieved in a timely and efficient manner with a strict commitment to quality.

All calibrations are performed in accordance with the test Method(s) identified in this protocol. If a Method allows for more than one calibration approach, or if approved alternatives are available, the calibration documentation in the appendices specifies which approach is used. All measurement devices are calibrated or verified at set intervals against standards traceable to the National Institute of Standards and Technology (NIST). NIST traceability information is available upon request.

Raw data are kept on file at the TRC office in Burr Ridge, Illinois. All samples from the test program are retained for 60 days after the submittal of the report, after which they are discarded unless TRC is advised otherwise.

Calculations are performed on the computer. An explanation of the nomenclature and calculations along with the complete test results are appended. Also to be appended are calibration data and copies of the raw field data sheets.

Sample Location Information - Round Duct

Project #: 235932.0

Company: United States Gypsum

Plant: Walworth Interiors

Unit ID: Cupola

Sample Location: Stack

Distance A: 30.00 feet, 8.62 Duct Diameters

Distance B: 30.00 feet, 8.62 Duct Diameters

Duct Diameter: 3.48 feet

of Ports Used: 2

of Points/Diameter: 12

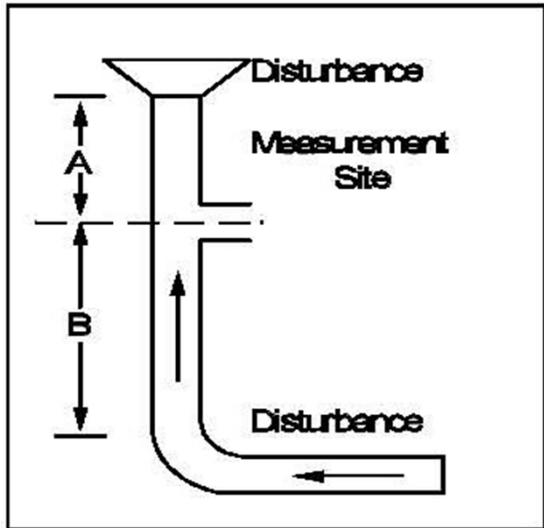
Sample Plane: Horizontal

Port Type: Nipple

Port Length: 3.0 inches

Port Inside Diameter: 3.0 inches

Traverse Point Locations



Point	% of diameter	Inches from wall	Inches from port edge
1	2.1	1.0	4.0
2	6.7	2.8	5.8
3	11.8	4.9	7.9
4	17.7	7.4	10.4
5	25.0	10.4	13.4
6	35.6	14.9	17.9
7	64.4	26.9	29.9
8	75.0	31.3	34.3
9	82.3	34.4	37.4
10	88.2	36.8	39.8
11	93.3	39.0	42.0
12	97.9	40.8	43.8

Part 60 Compliance Test

Initial Stratification Check and Test Point Selection

Project Number: - Date: -
Customer: - Duct Shape:
Unit Identification: - feet
Sample Location: -
Port Length: inches

Diameter is less than 4 inches - No Strat Test Required

Number of Points Used for Stratification Check:

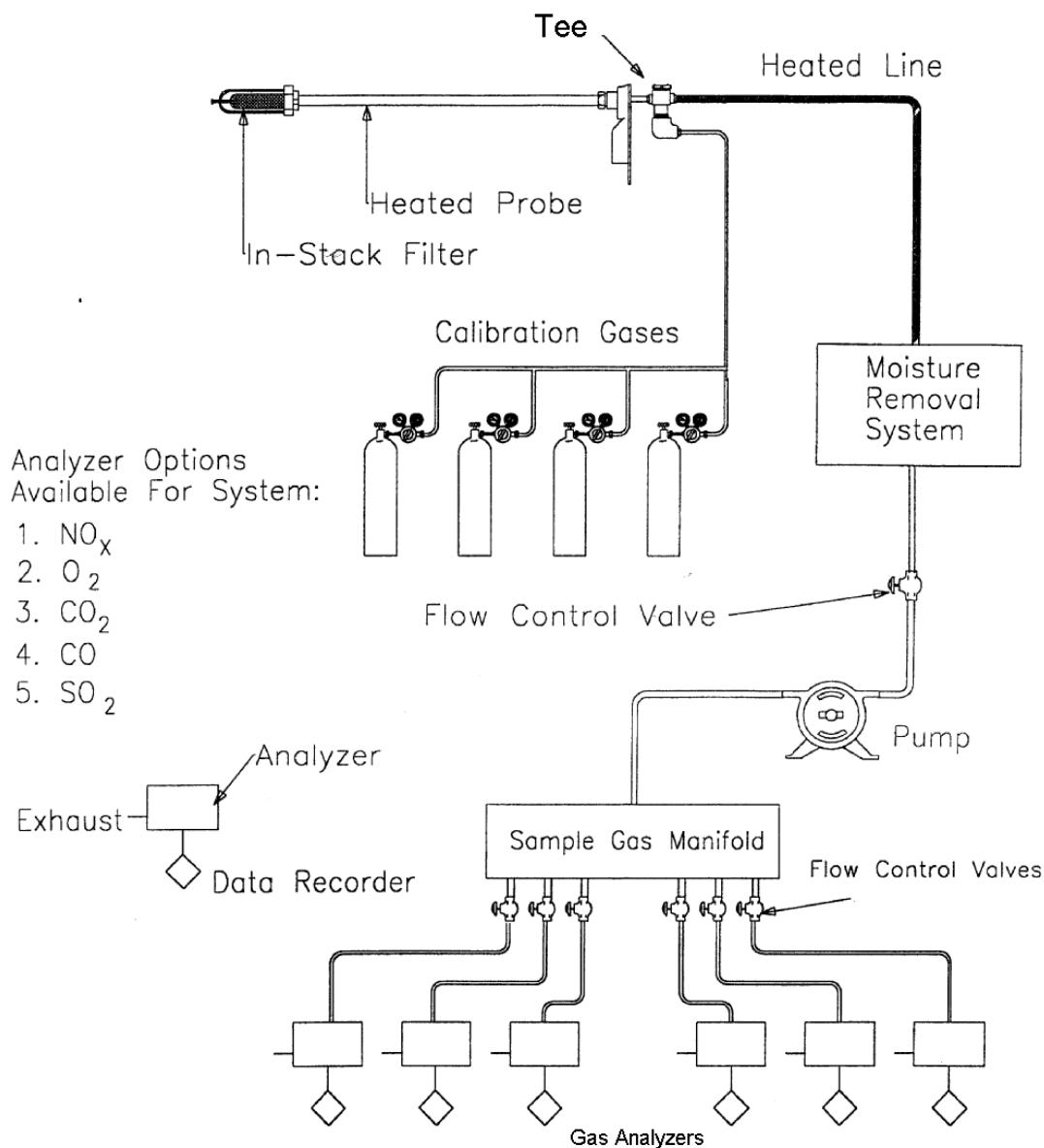
Mean:

Parameter	Max Raw Difference	Max % Difference From Mean	Result	Number of Points
NO _x				
SO ₂				
CO				
CO ₂				
O ₂				

Sampling line/strategy selected?:

Determination of Multiple Gaseous Pollutants Using an Extractive Sampling Train

USEPA Promulgated Methods 3A, 6C



Instrumental Reference Method Field Data

Project Number: _____ - Start Date: _____ -
Customer: _____ - End Date: _____ -
Unit Identification: _____ - Facility: _____ -
Sample Location: _____ - Recorded by: _____ -
Load Level/Condition: _____ - Fc Factor: _____ -
Fd Factor: _____ -

Test Parameter				NO _x	SO ₂	CO	CO ₂	O ₂	Volumetric Flow Rate	Moisture Fraction
Calibration Span, CS (Day 1)				-	-	-	-	-		
Calibration Span, CS (Day 2)				-	-	-	-	-	DSCFM	Bws
Run No.	Date	First Minute	Last Minute	Run Average Raw Analyzer Responses						
1	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-

Instrumental Reference Method Field Data

Project Number:	-	Start Date:	-
Customer:	-	End Date:	-
Unit Identification:	-	Facility:	-
Sample Location:	-	Recorded by:	-
Load Level/Condition:	-	Fc Factor:	-
		Fd Factor:	-

Actual Concentration of the Upscale Calibration Gas, C_{MA}					
	NO _x	SO ₂	CO	CO ₂	O ₂
C _{MA} (Day 1)	-	-	-	-	-
C _{MA} (Day 2)	-	-	-	-	-

System Responses to Zero Calibration Gas										
Run No.	NO _x		SO ₂		CO		CO ₂		O ₂	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-

System Responses to Upscale Calibration Gas										
Run No.	NO _x		SO ₂		CO		CO ₂		O ₂	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-

Instrumental Reference Method Field Data

Project Number: -
 Customer: -
 Unit Identification: -
 Sample Location: -
 Load Level/Condition: -

Date: -
 Facility: -
 Recorded by: -
 Fc Factor: -
 Fd Factor: -

RM Analyzer Information				
Reference Method Probe Type (Moisture Basis): -				
Pollutant	Manufacturer	Model #	Serial Number	
NO _x	-	-		-
SO ₂	-	-		-
CO	-	-		-
CO ₂	-	-		-
O ₂	-	-		-

Reference Method Initial Calibration Error Test							
Pollutant	Cal Gas Level	Cal Gas Cylinder Information			Analyzer Response	Absolute Difference	% Cal Error
		Concentration	Exp Date	ID #			
NO _x	Low	-	-	-	-	-	-
	Mid	-	-	-	-	-	-
	High	-	-	-	-	-	-
SO ₂	Low	-	-	-	-	-	-
	Mid	-	-	-	-	-	-
	High	-	-	-	-	-	-
CO	Low	-	-	-	-	-	-
	Mid	-	-	-	-	-	-
	High	-	-	-	-	-	-
CO ₂	Low	-	-	-	-	-	-
	Mid	-	-	-	-	-	-
	High	-	-	-	-	-	-
O ₂	Low	-	-	-	-	-	-
	Mid	-	-	-	-	-	-
	High	-	-	-	-	-	-

CEM System Information				
CEM System Probe Type (Moisture Basis): -				
Pollutant	Manufacturer/Model	Serial Number		
		Primary	Backup	
NO _x	-	-		-
SO ₂	-	-		-
CO	-	-		-
CO ₂	-	-		-
O ₂	-	-		-

Instrumental Reference Method Calibration Data

Project Number:	-	Start Date:	-
Customer:	-	End Date:	-
Unit Identification:	-	Facility:	-
Sample Location:	-	Recorded by:	-

SO₂ System Bias/Calibration Error and Drift Summary

Run #	Calibration Gas Level	Span	Cdir	Initial Values		Final Values		Drift (% of span)
		Span Gas Concentration (ppm)	Direct Cal Response (ppm)	System Response (ppm)	System Bias (% of span)	System Response (ppm)	System Bias (% of span)	
1	Low Level Gas	-	-	-	-	-	-	-
	Upscale Gas	-	-	-	-	-	-	-
2	Low Level Gas	-	-	-	-	-	-	-
	Upscale Gas	-	-	-	-	-	-	-
3	Low Level Gas	-	-	-	-	-	-	-
	Upscale Gas	-	-	-	-	-	-	-
4	Low Level Gas	-	-	-	-	-	-	-
	Upscale Gas	-	-	-	-	-	-	-
5	Low Level Gas	-	-	-	-	-	-	-
	Upscale Gas	-	-	-	-	-	-	-
6	Low Level Gas	-	-	-	-	-	-	-
	Upscale Gas	-	-	-	-	-	-	-
8	Low Level Gas	-	-	-	-	-	-	-
	Upscale Gas	-	-	-	-	-	-	-
8	Low Level Gas	-	-	-	-	-	-	-
	Upscale Gas	-	-	-	-	-	-	-
9	Low Level Gas	-	-	-	-	-	-	-
	Upscale Gas	-	-	-	-	-	-	-
-	Low Level Gas	-	-	-	-	-	-	-
	Upscale Gas	-	-	-	-	-	-	-
-	Low Level Gas	-	-	-	-	-	-	-
	Upscale Gas	-	-	-	-	-	-	-
-	Low Level Gas	-	-	-	-	-	-	-
	Upscale Gas	-	-	-	-	-	-	-

Instrumental Reference Method Calibration Data

Project Number: _____ - Start Date: _____ -
Customer: _____ - End Date: _____ -
Unit Identification: _____ - Facility: _____ -
Sample Location: _____ - Recorded by: _____ -

O₂ System Bias/Calibration Error and Drift Summary

Run #	Calibration Gas Level	Span	Cdir	Initial Values		Final Values		Drift (% of span)
		Span Gas Concentration (%vol)	Direct Cal Response (ppm)	System Response (%vol)	System Bias (% of span)	System Response (%vol)	System Bias (% of span)	
1	Low Level Gas	-	-	-	-	-	-	-
	Upscale Gas	-	-	-	-	-	-	-
2	Low Level Gas	-	-	-	-	-	-	-
	Upscale Gas	-	-	-	-	-	-	-
3	Low Level Gas	-	-	-	-	-	-	-
	Upscale Gas	-	-	-	-	-	-	-
4	Low Level Gas	-	-	-	-	-	-	-
	Upscale Gas	-	-	-	-	-	-	-
5	Low Level Gas	-	-	-	-	-	-	-
	Upscale Gas	-	-	-	-	-	-	-
6	Low Level Gas	-	-	-	-	-	-	-
	Upscale Gas	-	-	-	-	-	-	-
8	Low Level Gas	-	-	-	-	-	-	-
	Upscale Gas	-	-	-	-	-	-	-
8	Low Level Gas	-	-	-	-	-	-	-
	Upscale Gas	-	-	-	-	-	-	-
9	Low Level Gas	-	-	-	-	-	-	-
	Upscale Gas	-	-	-	-	-	-	-
-	Low Level Gas	-	-	-	-	-	-	-
	Upscale Gas	-	-	-	-	-	-	-
-	Low Level Gas	-	-	-	-	-	-	-
	Upscale Gas	-	-	-	-	-	-	-
-	Low Level Gas	-	-	-	-	-	-	-
	Upscale Gas	-	-	-	-	-	-	-

**Instrumental Reference Method
Calibration Corrected Test Data**

Project Number: -
 Customer: -
 Unit Identification: -
 Sample Location: -
 RM Probe Type: -
 Load Level/Condition: -

Start Date: -
 End Date: -
 Facility: -
 Recorded by: -
 Fc Factor: -
 Fd Factor: -

Reference Method Results, As Measured Moisture Basis

Run #	Date	Start Time	End Time	NOX ppmvd	SO2 ppmvd	CO ppmvd	CO2 % v/v dry	O2 % v/v dry
1	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-

Moisture Correction Applied To "As Measured Data": None

Reference Method Results, CEM Moisture Basis

Run #	NOX ppmvd	SO2 ppmvd	CO ppmvd	CO2 % v/v dry	O2 % v/v dry	Bws	Fc Factor	Fd Factor
1	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-

Emission Rate Calculation Summary

Run #	NOX lb/MMBtu	SO2 lb/MMBtu	CO lb/MMBtu	NOX lb/hr	SO2 lb/hr	CO lb/hr	Flow DSCFM
1	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-

Instrumental Reference Method
Calibration Corrected Test Data

Project Number: -
Customer: -
Unit Identification: -
Sample Location: -
RM Probe Type: -
Load Level/Condition: -

Start Date: -
End Date: -
Facility: -
Recorded by: -
Fc Factor: -
Fd Factor: -

Emission Rate Test Calculation Summary lb/MMBtu Determined Using lb/hr Emission Rate and Heat Input				
Run #	Heat Input MMBtu/Hr	NOX lb/MMBtu	SO2 lb/MMBtu	CO lb/MMBtu
1	-	-	-	-
2	-	-	-	-
3	-	-	-	-
4	-	-	-	-
5	-	-	-	-
6	-	-	-	-
7	-	-	-	-
8	-	-	-	-
9	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-

Example Calculations - Effluent Gas Concentration Determination

Project Number:	-	Test Date:	-
Customer:	-	Facility:	-
Unit Identification:	-	Run #:	1
Sample Location:	-		

$$C_{\text{gas}} = (C - C_0) \times \frac{C_{\text{ma}}}{C_m - C_0}$$

Where:

C_{gas} = Effluent gas concentration (ppm or %vol)

C = Average gas concentration indicated by analyzer (ppm or %vol)

C_0 = Average of pre- and post-test system bias checks using low range gas (ppm or % vol)

C_m = Average of pre- and post-test system bias checks using upscale gas (ppm or % vol)

C_{ma} = Actual concentration of upscale gas (ppm or % vol)

NO_x	C = -	ppm	C₀ = -	ppm
	C_m = -	ppm	C_{ma} = -	ppm

C_{NOX} = - ppm

SO₂	C = -	ppm	C₀ = -	ppm
	C_m = -	ppm	C_{ma} = -	ppm

C_{SO2} = - ppm

CO	C = -	ppm	C₀ = -	ppm
	C_m = -	ppm	C_{ma} = -	ppm

C_{CO} = - ppm

CO₂	C = -	%vol	C₀ = -	%vol
	C_m = -	%vol	C_{ma} = -	%vol

C_{CO2} = - %vol

O₂	C = -	%vol	C₀ = -	%vol
	C_m = -	%vol	C_{ma} = -	%vol

C_{O2} = - %vol

Note: Interim results are not rounded.

Example Calculations - Pollutant Emission Rate, Oxygen-Based Fuel Factor

Project Number: - _____ Test Date: - _____
Customer: - _____ Facility: - _____
Unit Identification: - _____ Run #: 1

ER = Pollutant emission rate (lb/MMBtu)

C_{gas} = Pollutant concentration (ppm dry basis)

MW = Pollutant molecular weight (gr/gr-mole)

F_d = Oxygen-based fuel factor (dscf/MMBtu)

%O₂ = Concentration of oxygen in effluent gas (%vol dry basis)

1.194E-07 = Conversion constant for NOx. From Table 19-1 of Method 19, 40CFR, Appendix A

1.660E-07 = Conversion constant for SO₂. From Table 19-1 of Method 19, 40CFR, Appendix A

7.269E-08 = Conversion constant for CO. Derived based on Table 19-1 of Method 19, 40CFR60, App. A

(See GE Energy Form 1006e for derivation of factors for CO)

For NOx ER = C_{gas} x 1.194E-07 x F_d x (20.9/(20.9-%O₂))

NOx C_{gas} = - ppm %O₂ = - %vol
 F_d = - dscf/MMBtu

ER_{NOx} = #VALUE! lb/MMBtu

For SO₂ ER = C_{gas} x 1.660E-07 x F_d x (20.9/(20.9-%O₂))

SO₂ C_{gas} = - ppm %O₂ = - %vol
 F_d = - dscf/MMBtu

ER_{SO2} = #VALUE! lb/MMBtu

For CO ER = C_{gas} x 7.269E-08 x F_d x (20.9/(20.9-%O₂))

CO C_{gas} = - ppm %O₂ = - %vol
 F_d = - dscf/MMBtu

ER_{CO} = #VALUE! lb/MMBtu

Note: Interim results are not rounded.

Response Time Verification

Project Number:	-	Test Date:	-
Customer:	-	Facility:	-
Unit Identification:	-	Recorded By:	-
Sample Location:	-		

Upscale Response Check							
Pollutant	Cal Gas Level	Cal Gas Conc.	Start Time	Stable Response	Upscale Target Response	Time at Target	Response Time
NO _x	-	-	-	-	-	-	-
SO ₂	-	-	-	-	-	-	-
CO	-	-	-	-	-	-	-
CO ₂	-	-	-	-	-	-	-
O ₂	-	-	-	-	-	-	-

Target Response is 95% of the Pre 1 System Response from the Upscale Bias Test

Start time is the time at which gas is introduced upstream of the probe.

Time at target is the time at which the required target response is achieved.

Response time is the difference between the two.

Downscale Response Check						
Pollutant	Cal Gas Level	Cal Gas Conc.	Start Time	Downscale Target Response	Time at Target	Response Time
NO _x	-	-	-	-	-	-
SO ₂	-	-	-	-	-	-
CO	-	-	-	-	-	-
CO ₂	-	-	-	-	-	-
O ₂	-	-	-	-	-	-

Target Response is 0.5 ppm or 5.0 percent of the upscale gas concentration (whichever is less restrictive)

System Response Times	
Pollutant	Response Time
NO _x	0:00:00
SO ₂	0:00:00
CO	0:00:00
CO ₂	0:00:00
O ₂	0:00:00

System response is the longer of the responses to zero and upscale gas.